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ABSTRACT

This learner's guide is designed to meet the training needs for technicians involved in monitoring activities related to the Federal Water Pollution Act and the Safe Drinking Water Act. In addition it will assist technicians in learning how to perform process control laboratory procedures for drinking water and wastewater treatment plant operations, as well as those tests, analyses, and procedures required by local, state, and federal regulatory agencies. Contained in the guide are nine courses, comprising 93 instructional modules. The complete curriculum can be taken in two years. The sequence in which the courses should be taken is given. However, each course is independent of the others and a variety of instructional pathways is possible for training technicians to do specific tasks. Each instructional unit gives the purpose, prerequisites, resources, objectives, conditions, and expected performance level. Included in the guide are units on: autoclaves, biochemical oxygen demand, functions of wastewater treatment processes, grit analysis, gas chromatography, and sampling routines. (BB)

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Learner's Guide
WATER QUALITY MONITORING

An Instructional Guide for the
Two-Year Water Quality Monitoring Curriculum

JUNE 1978

AWARDED TO

Water Quality Monitoring Project
Ulster County Community College
Stone Ridge, New York 21484

PROJECT FUNDED BY

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Summary

This *Learner's Guide* is designed to meet the training needs for technicians involved in monitoring activities related to the Federal Water Pollution Act of 1972 and the Safe Drinking Water Act. In addition, it will assist technicians in learning how to perform process control laboratory procedures for drinking water and wastewater treatment plant operations, as well as those tests, analyses, and procedures required by local, state, and federal regulatory agencies.

The *Learner's Guide* uses the behavioral objective format as the foundation for constructing a total learning system, including clearly defined instructional objectives, instructional guides, and learning modules (many consisting of audio-visual materials). The system should serve as an "academic cafeteria" in the training of water management students through which trainees can master the entire *Guide*, sections of the *Guide*, or any sequence of *Guide* objectives they desire to obtain a specific goal. Of equal importance is that the system, as developed here, provides the tools to release the teacher from his role as lecturer and laboratory instructor to become a manager, or facilitator, of learning. Further, this system can--and should--be applied to the development of educational systems in other environmental disciplines, as well as health, science, liberal arts, and many other fields.

Introduction

This *Learner's Guide* is derived from *A Two-Year Water Quality Monitoring Curriculum*, which was published in 1975. It uses and expands upon the behavioral objective format developed in the curriculum; however, it is more definitive than the curriculum, taking the trainee through a step-by-step series of objectives to the completion of a single task, course, series of courses or the entire program.

What is presented here is a model program which lays out the major steps for a complete *educational system* for water quality monitoring, a system which is flexible, composed of many independent parts, self-pacing, easily evaluated, readily modified, and highly transportable. It is these characteristics which enable the system to be utilized as an "academic cafeteria" in which the objectives (as learning units) can be selected and resequenced to meet a student's specific needs and goals. This flexibility, in turn, provides the tools to release the teacher from the traditional role of lecturer and lab instructor to become a leader, motivator, and facilitator of learning.

This new role becomes possible because, using independent learning units, the authors have defined clearly the goals to be achieved, the knowledge and skills necessary to achieve them, and the level of mastery that is necessary for competent on-the-job performance.

As the objectives in the *Learner's Guide* are independent units, they can be isolated and resequenced to provide a variety of pathways or "critical paths" (see page 13) to train students in a host of new techniques and skills or in the general knowledge to implement skills. Thus, not only can students perform these tasks, but they can reason, investigate, and apply their skills to new situations and advancing technology. Further, a great variety of workshops, seminars, symposiums, and on-the-job training programs of varying lengths and types can be lifted directly from this system and used in the training, retraining, upgrading or continuing education of water quality technicians.

These objectives are not theoretical, but have been field-tested in the classroom at Ulster County Community College for the last three years with a high degree of success.

With this *Guide* the instructor can now develop, evaluate, and use numerous instructional strategies for any given objective or set of objectives. In addition, when the critical pathways are identified and approved, appropriate instructional materials (workbooks, audio-visual materials, simulations, etc.) can be designed and produced to complete this educational system for environmental training.

Future Work

The completion of the *Learner's Guide* brings the use of behavioral objectives to a point where they provide an educational flexibility and freedom of selection not available previously in the water quality monitoring field. A true educational "system" is now much closer to realization for the field; however, if this goal is to be reached, it is necessary that instructional materials, such as modules and minicourses, be produced to implement the *Learner's Guide*. These modules should be independent, self-pacing, self-testing, and confined whenever possible to a single concept broken down into one or more learning objectives.

It is further recommended that:

1. Additional programs in the environmental control field -- air pollution, solid waste management, and others -- be developed along lines similar to the water quality monitoring program.
2. The *Guide* be evaluated continually to determine its effectiveness in producing graduates who can fill positions in the water quality monitoring field.

An important aspect of any continuation of this effort would be close coordination with similar activities producing curricula and instructional materials that could be utilized directly in, or be used to give guidance to, the further implementation of this technician's curriculum. A number of these efforts have produced performance-oriented instructional materials that are suitable for use in the curriculum described in this book and in *A Two-Year Water Quality Monitoring Curriculum*. The following list represents some of the organizations.

Project BIOTECH
American Institute of Biological Sciences
3900 Wisconsin Avenue NW
Washington, DC 20016
(202) 244-5581

Project CIVTEC
State Board for Technical and Comprehensive Education
1429 Senate Street
Columbia, SC 29201
(803) 758-3171

Standard Field Operation Procedures
Water Program Operations
Manpower Development Staff
National Training Center, EPA
Cincinnati, OH 45268
(513) 684-8223

Project Coordinator
TECH Physics Project
American Institute of Physics
Indiana State University
Terre Haute, IN 47804
(812) 232-6311 Ext. 5355

Wastewater Technician Training (CEWT)
Manpower Training Branch
Office of Water Program Operations
Environmental Protection Agency
Washington, DC 20460
(703) 557-7363

Preprofessional Individually Paced Instruction (PIPI)
College of Engineering
Oklahoma State University
Stillwater, OK 74074
(405) 372-6211 Ext. 7551

Standard Operating Job Procedures
Pollution Abatement Technology (PAT)
Charles County Community College
LaPlata, MD 20646
(301) 934-2251

List of Courses

There are nine courses, comprising 93 instructional modules, in this *Learner's Guide*. The courses and modules are listed below.

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Alternative Approaches To Curriculum Use

INTRODUCTION

The behavioral objective format of the two-year curriculum, and this learner's guide, offers instructors, curriculum developers, and students the flexibility to develop a multitude of pathways--to meet varying or changing training and technician needs--that cannot be developed using the classical course description approach. These pathways enable students to enter and proceed from different entry points, or to obtain partial skills which may not lead to a degree, but will still make the individual employable or more useful in his occupation. Some of these alternate approaches are discussed below.

COMPLETE CURRICULUM

The sequence in which each course in each subject area in the complete curriculum should be taken and the relationship of one subject area and course to another are noted in Figure 1 (page 15) The service courses in Chemistry, Biology, Mathematics, and English are to be taken in the semester prior to the one in which mastery of the subject area is needed for the Environmental Science sequence. The social science course and the electives can be taken wherever it best fits into the student's two-year schedule.

In all subsequent examples the trainee must meet required prerequisites or demonstrate mastery of the skills at the performance level indicated in the individual curriculum courses.

ENTRY WITH ASSOCIATE DEGREE IN THE SCIENCES OR RELATED FIELDS

An entering trainee with an associate degree in the sciences or related fields should be allowed credit for all courses successfully completed. An example of this would be a prior degree in chemical technology as illustrated in Figure 2 (page 16). Thus, a program can be designed to provide entering trainees with the knowledge and skills necessary to complete the Environmental Science sequence in about one year.

ENTRY FOR TREATMENT PLANT OPERATOR

The program offers the treatment plant operator the opportunity to develop his knowledge and skills in the laboratory control area without having to complete the entire degree sequence. Figure 3 (page 16) suggests a sequence for obtaining these skills.

The material in Environmental Science 104 could be mastered in the trainee's lab at any time during the training program. The trainee can proceed through both stems simultaneously. Because of prior experience, many operators may be able to omit Environmental Science 103.

CRITICAL PATHS

Because it stands as an independent unit, each objective can be isolated and sequenced to provide a variety of instructional (critical) pathways for training technicians to do specific

tasks. For instance, two of the major areas required in the NPDES monitoring program are the determination of indicator organisms (namely, fecal and total coliforms and fecal streptococci) and nutrient analyses of organic and Kjeldahl nitrogen, ammonia, nitrate, nitrite, orthophosphate, and total phosphorus. If it becomes necessary to train a technician to do these basic tests or, conversely, if a technician on his own desires to learn how to do these tasks, he can be prepared or can prepare himself by selecting those objectives which pertain to mastering the techniques as noted in Figure 4. ("Math 101:12" indicates objective 12 of the course "Mathematics 101." "Chem 101:45a,j,l" indicates objective 45, parts a, j, and l, of the course "Chemistry 101.")

By proper selection and sequencing, the trainee can master these analyses in an extremely short time compared to the normal two-year requirement to complete the entire curriculum. Additionally, if appropriate instructional materials are available for each objective, then the pathways can become a self-learning program requiring minimal participation by the instructional or supervising staff.

To illustrate this point and to provide a further example of the significance of Critical Paths, two volumes have been developed using the objectives from the *Learner's Guide* and completing those pertinent objectives from Math and Chemistry courses that were not completed in the *Learner's Guide* because of limited resources. These two volumes, *Nutrients* and *Indicator Organisms*, take the trainee through the step-by-step sequences needed to accomplish these tasks (see Figure 4). When these objectives are completed and coupled with learning modules, the process becomes an independent, self-pacing learning process which offers the instructor the flexibility to become a manager and facilitator of learning and frees the student from the constraint of a rigid, classical education.

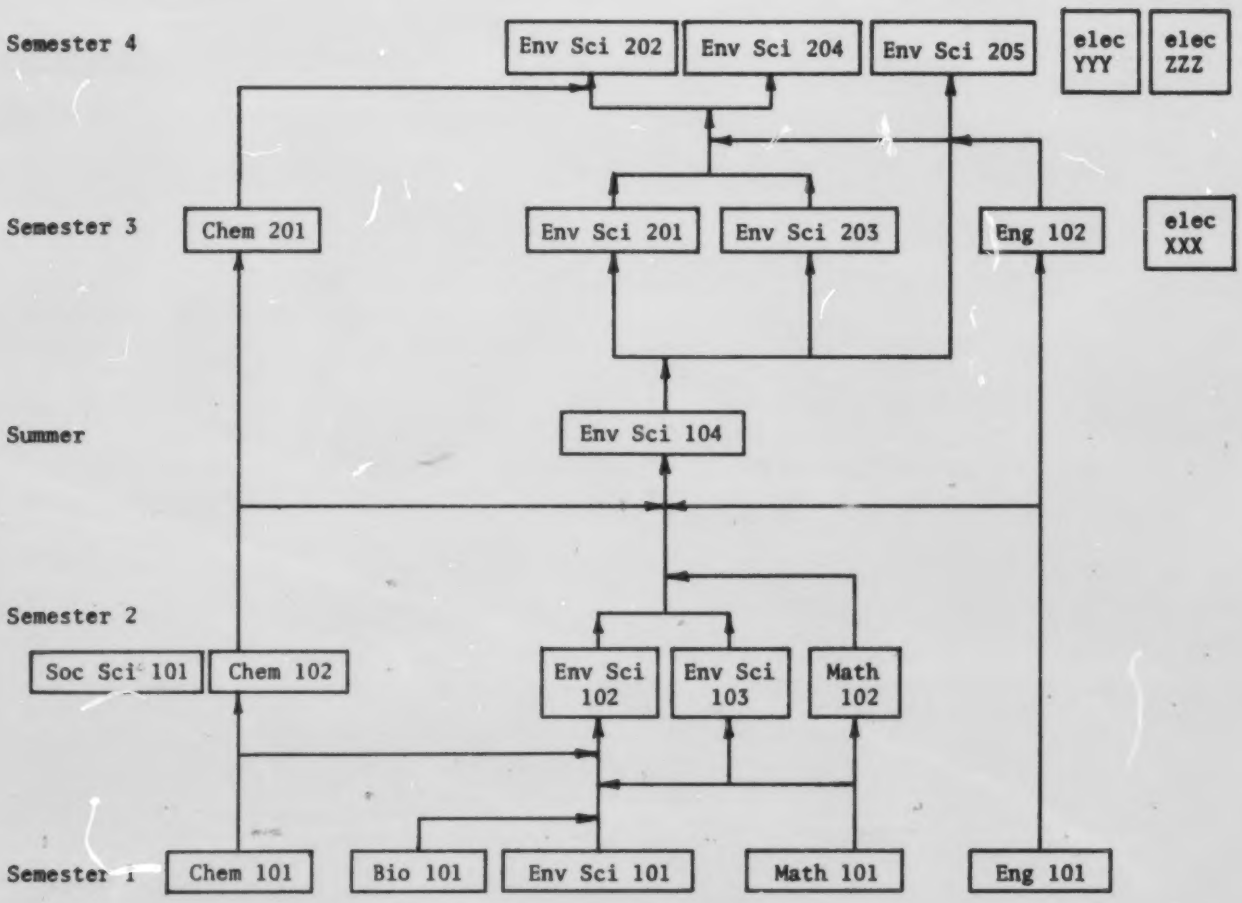
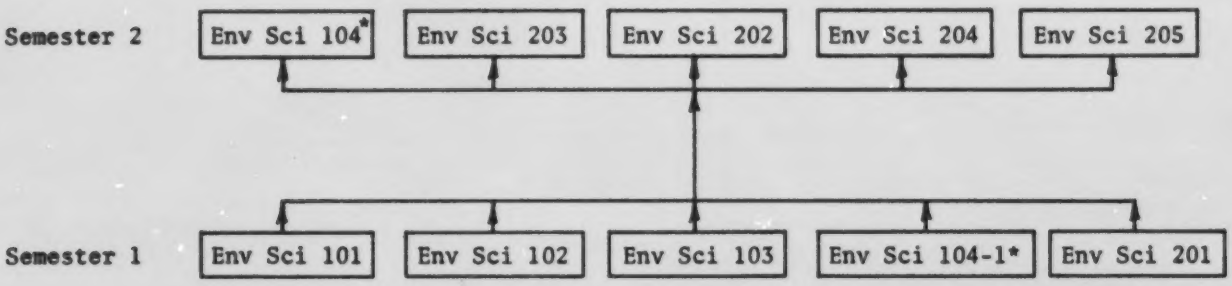


FIGURE 1
Course Sequence and Subject Area Relationship



*Env Sci 104 is divided so that 1 credit hour is taken the first semester and 2 credit hours the second semester. Alternatively, the course could be taken during the regular summer practicum at the end of the second semester, or it could be taken as an independent study course consisting of part-time work in a treatment plant during the school year.

FIGURE 2
Entry with Associate Degree in the Sciences or Related Fields

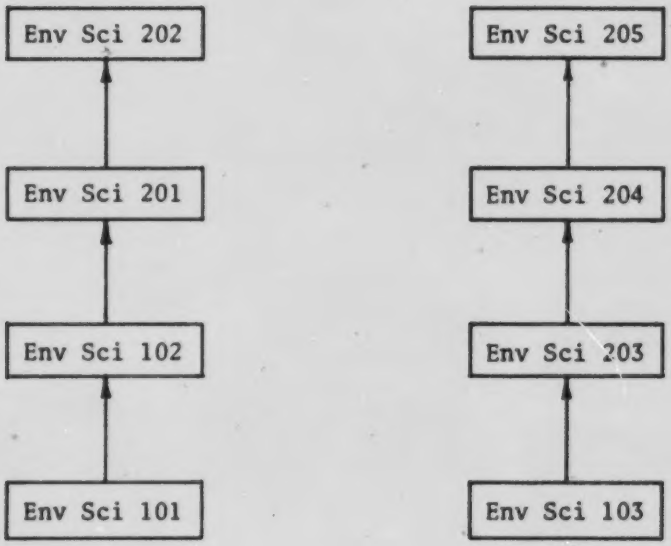


FIGURE 3
Entry for Treatment Plant Operator

COMPETENCE IN

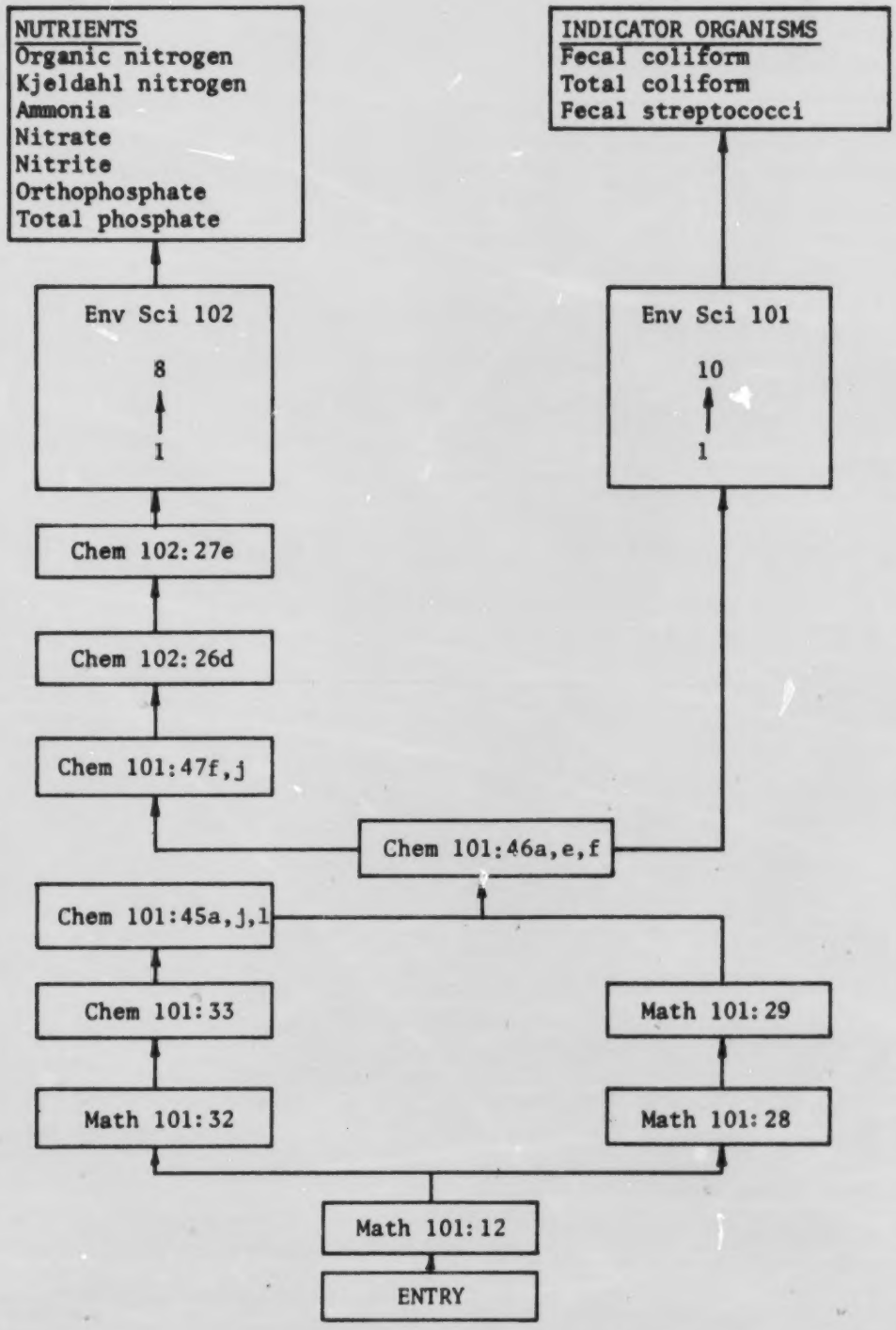


FIGURE 4
Suggested Sequence of Specific Objectives To Prepare Technician For Analyses of Nutrients and Indicator Organisms

How To Use the Learner's Guide

Each course in this guide is introduced with a statement of purpose, and then broken down into a number of units of instruction, each containing an objective (OBJ), learning conditions (COND), and a performance level (PL).

The statement of purpose is a synopsis of the course material and explains what the student will be studying. It deals with the relevance of the subject material and explains why the student is to master the course skills and knowledge covered in the course. The student should understand why he should master the learning objectives and how the course fits into the total sequence of his learning.

The OBJ tells the student precisely what he must be able to do after mastering the unit of instruction.

The COND tells the student (and the instructor) the circumstances under which the student will perform or the objects, information or assistance the student will have access to while performing. The student should perform under conditions as close to real situations as is practical in the instructional situation.

The PL tells the student the acceptable level of performance that will be required of him to demonstrate mastery of the objective. The PL is sometimes referred to as the "terminal behavior."

Each objective in the *Learner's Guide* is cross referenced to *A Two-Year Water Quality Curriculum*. The title of each complete learning module is indicated at the top of the page, with the location in the curriculum coded by course and number. The descriptive prefix and the first number refer to the course in which the module's objectives are found. The second number, following the colon, refers to the number of the pertinent objective in the curriculum, and the third number (in parentheses), is the page in the curriculum on which the objective is found. In certain cases there may be a fourth designation with a PL in front of it. This refers to a specific performance level in the noted objective. An example would be:

Env Sci 204:1, PL 5(100)

This would be read as Environmental Science 204, objective 1, performance level 5, page 100 (sampling routine). Occasionally, there may be a number in parentheses immediately following the course number, as in Env Sci 201(10):1 (81). The "10" in this case refers to a list given prior to the statement of objectives in the curriculum, and means that the module refers to objective 1 *for item #10* of that list.

Courses

Double Pan Analytical Balance

ENV SCI 101:1a(49)

PURPOSE

This guide will assist you in learning to use the popular double pan analytical balance. The double pan analytical balance is used for very accurate weighings (± 0.1 mg), is cheaper than electric balances, but is very slow in operation.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 404, 2302, 2911 (Module 19)
Manufacturer's manual

OBJECTIVES

OBJ 1: Identify the major features of a double pan analytical balance.

COND: Given the balance or pictures or sketches of this balance.

PL: Include:

a. Balance pans
b. Pan arrests
c. Pan arrest knob
d. Beam
e. Beam support
f. Beam support control knob
g. Knife edges
h. Level indicator
i. Level adjust
*j. Rider
*k. Chain
l. Rider or chain control arm and handle
m. Zero adjust screws
n. Pointer
o. Pointer scale
p. Gravity adjustment weight
q. Sliding doors
r. Standard weights

*Some balances may have rider or chain or both.

OBJ 2: Demonstrate and explain the use of the major features of a double pan analytical balance.

COND: Given the balance and resources.

PL: Each of the features in OBJ 1 should be used and its use explained in your own words.

OBJ 3: Determine the location of the zero pointer and zero the balance.

COND: Given the balance and resources.

PL: The pointer must swing freely and for the same distance on each side of the zero mark.

OBJ 4: State rules for using a balance.

COND: Given the balances or pictures or sketches of them.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Handle objects with tongs, forceps or tissues to avoid fingerprints.

g. Place objects to be weighed near the center of the pan.
h. Clean and dust the pan before and after each weighing.
i. Do not lean on the balance table while weighing.
j. Remove all objects and weights, and lock the pan and beam at completion of weighing.
k. Use the same balance for all comparative weighing.

OBJ 5: Weigh a solid object and a liquid sample on the double pan analytical balance.

COND: Given a solid object, a beaker, water, tongs, weighing paper, the balance, and resources.

PL: Weights should be accurate to ± 0.2 mg, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Double pan analytical balance	x	x	x	x	x			
50 ml beaker or weighing bottle					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Set of standard weights					x			
Tweezers or forceps					x			
Spatula					x			
Camel's hair brush				x	x			

Electric Single Pan Analytical Balance

ENV SCI 101:1a(49)

PURPOSE

This guide will assist you in learning to use an electric single pan analytical balance. Many tests require accuracy of ± 0.1 mg, which is only possible with analytical balances. The electric single pan analytical balance is expensive, but easy and quick to use.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 404, 1060, 2911 (Module 20)
Manufacturer's manual

OBJECTIVES

OBJ 1: Identify the major features of an electric single pan analytical balance.

COND: Given the balance or pictures or sketches of this balance.

PL: Include:

a. Balance pan
b. Level indicator
c. Level adjust
d. Pan arrest
e. Zero adjust
f. Tare adjust
g. Weight control for 100 g, 10 g, 1 g
h. Micrometer control for fractions of grams
i. Optical scales for reading 100 g, 10 g, 1 g, and fractional mg weights
j. Sliding door

OBJ 2: Demonstrate and explain the use of each of the major features of an electric single pan analytical balance.

COND: Given the balance and a resource.

PL: The use of each of the features listed in OBJ 1 should be demonstrated and explained.

OBJ 3: Zero an electric single pan analytical balance.

COND: Given the balance and a resource.

PL: The zero should be reproducible to ± 0.1 mg.

OBJ 4: State the rules for using a balance.

COND: Given the balance or pictures or sketches of this balance.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beams.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Handle objects with tongs, forceps or tissues to avoid fingerprints.
g. Place objects to be weighed near the center of the pan.
h. Clean and dust the pan before and after each weighing.
i. Do not lean on the balance table while weighing.
j. Remove all objects and weights, and lock the pan and beam at completion of weighing.

k. Use the same balance for all comparative weighing.

OBJ 5: Weigh a solid object and a liquid sample on an electric single pan analytical balance.

COND: Given the balance, a solid object, a beaker, water, tongs, weighing paper, and resources.

PL: Weights should be accurate to ± 0.2 mg, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Electric single pan analytical balance	x	x	x	x	x			
50 ml beaker or weighing bottle					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Spatula					x			
Camel's hair brush				x	x			

Electric Top-Loading Balance

ENV SCI 101:1a(49)

PURPOSE

This guide will assist you in learning how and when to operate an electric top-loading balance. This is an expensive, fast, easily used balance with an accuracy of ± 1 mg, which is sufficient for most tests.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 404, 2911 (Module 18)
Manufacturer's Manual

OBJECTIVES

OBJ 1: Identify the major features of an electric top-loading balance.

COND: Given the balance or pictures or sketches of this balance.

PL: Include:

a. On-off switch
b. Balance pan
c. Level indicator
d. Level adjust
*e. Pan arrest
f. Zero adjust
g. Tare adjust
h. 10 g optical scale
i. 10 g adjust
j. 0.001 g optical scale
k. 0.001 g adjust

*The pan arrest may not be available on this balance.

OBJ 2: Demonstrate and explain the use of each of the major features of an electric top-loading balance.

COND: Given the balance and a resource.

PL: The use of each of the features listed in OBJ 1 should be demonstrated and explained.

OBJ 3: Zero an electric top-loading balance.

COND: Given the balance and a resource.

PL: The zero should be reproducible to ± 0.001 g.

OBJ 4: State the rules for using a balance.

COND: Given the balances or pictures or sketches of them.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Handle objects with tongs, forceps or tissues to avoid fingerprints.
g. Place objects to be weighed near the center of the pan.
h. Clean and dust the pan before and after each weighing.
i. Do not lean on the balance table while weighing.

j. Remove all objects and weights, and lock the pan and beam at completion of weighing.
k. Use the same balance for all comparative weighing.

OBJ 5: Weigh a solid object and a liquid sample on an electric top-loading balance.

COND: Given the balance, a solid object, a beaker, water, tongs, weighing paper, and resources.

PL: Weights should be accurate to ± 0.002 g, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Electric top-loading balance	x	x	x	x	x			
50 or 125 ml beaker					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Camel's hair brush				x	x			
Spatula					x			

Triple Beam and Double Pan Balances

ENV SCI 101:1a(49)

PURPOSE

This guide will assist you in learning how to use and care for triple beam and double pan balances. These are simple and quick to use and are sufficiently accurate for many routine weighings (those which require accuracy of only 0.1 g or, at most, 0.01 g).

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 2911 (Module 17)
Manufacturers' manuals

OBJECTIVES

OBJ 1: Identify the major features of triple beam and double pan balances.

COND: Given the balances or pictures or sketches of these balances.

PL: Include:

a. Beams
b. Balance pans
*c. Level indicator
*d. Beam arrest (lock)
e. Pan arrest (lock)
f. Zero adjust
g. Reference weights
h. Pointer
i. Fulcrum (knife edge)
j. Relative precision

*Often not found on these balances.

OBJ 2: State rules for using a balance.

COND: Given the balances or pictures or sketches of these balances.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Handle objects with tongs, forceps or tissues to avoid fingerprints.
g. Place objects to be weighed near the center of the pan.
h. Clean and dust the pan before and after each weighing.
i. Do not lean on the balance table while weighing.
j. Remove all objects and weights, and lock the pan and beam at completion of weighing.
k. Use the same balance for all comparative weighing.

OBJ 3: Weigh a solid object on the triple beam and double pan balances.

COND: Given an object, the balances, tongs, and resources.

PL: Weights should be accurate to ± 0.1 or ± 0.01 g, depending upon accuracy of the balance. All rules in OBJ 2 should be followed.

OBJ 4: Weigh a liquid sample on the triple beam and double pan balances.

COND: Given a beaker, water, the balances, tongs, and resources.

PL: Weights accurate to ± 0.1 or ± 0.01 g, depending upon the accuracy of the balance. All rules in OBJ 2 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Triple beam balance	x	x	x	x				
Double pan balance	x	x	x	x				
Tongs			x	x				
250 ml beaker				x				
Solid object or sample of solid chemical			x					
Water				x				
Camel's hair brush		x	x	x				
Set of reference weights		x	x	x				
Spatula			x					

Laboratory Ovens

ENV SCI 101:1b(49)

PURPOSE

This guide will assist you in learning to operate a laboratory oven for drying glassware, for preparing standard reagents by drying off moisture from their solid forms, and for sterilization. These drying operations at 50°C to 200°C are necessary to give accurate weighings for many tests.

PREREQUISITES

Before beginning this module you should have successfully completed the modules on Balances (Env Sci 101:1a) and Desiccators (Env Sci 101:1c), and you should be able to use a Celsius thermometer [Chem 101:46b(36)].

RESOURCES

IRIS: 2911 (Module 13)

OBJECTIVES

OBJ 1: Identify the major features of a laboratory oven.

COND: Given the oven or photographs or sketches of it.

PL: Include:

a. Temperature control
b. Thermometer or temperature gauge
c. On-off control
d. Door latch
e. Shelving and shelf-adjustment

OBJ 2: Adjust the shelves of an oven for small or large glassware.

COND: Given the oven and several short and tall beakers or flasks.

PL: Glassware should not touch a second shelf, but there should be no more than 5 cm excess height.

OBJ 3: Operate an oven at a given temperature.

COND: Given the oven, the temperature, and resources, including the operations manual for your oven.

PL: Standardize the temperature control settings with a thermometer, then set to ± 1°C using the standard form.

OBJ 4: Add and remove from a hot oven different items of glassware and crucibles.

COND: Given an equipped laboratory and resources.

PL: Use crucible and beaker tongs to prevent burns, spillage, breakage or contamination.

OBJ 5: Heat a solid sample to constant weight in an oven.

COND: Given an equipped laboratory and resources.

PL: Correct weight should be reproduced to ± 1% in 3 consecutive weighings.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Drying oven	x	x	x	x	x			
Beaker (250 ml)		x		x				
Erlenmeyer flasks (50 and 125 ml)		x		x				
Tongs				x				
Crucible				x				
Asbestos pad				x	x			
Weighing bottle or 50 ml beaker					x			
Desiccator					x			
Barium chloride ($BaCl_2 \cdot 2H_2O$)					x			

Desiccators

ENV SCI 101:1c(49)

PURPOSE

This guide will assist you in learning how to empty, refill, and lubricate a desiccator and how to handle it to transport hygoscopic substances. The desiccator is used to prevent such samples from picking up water from the atmosphere.

PREREQUISITES

Before beginning this module you should be able to name and use laboratory glassware.

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify and describe the use of the major features of a desiccator.

COND: Given a desiccator or a picture or sketch of a desiccator.

PL: Include the names of two or more desiccants, the techniques for transporting and storing hygoscopic substances, and the purpose of the crucible holder plate.

OBJ 2: Empty, clean, and refill a desiccator with desiccant.

COND: Given the desiccator, clean towels, and the desiccant.

PL: Refilled desiccator should have no adhering particles which could contaminate items to be dried. Desiccant should reach to about 2 cm of the crucible holder plate.

OBJ 3: Clean and regrease the desiccator and lid.

COND: Given an equipped laboratory.

PL: A thin, even layer of grease should give a firm, air-tight seal which does not easily slip.

OBJ 4: Place a hot crucible and lid in the desiccator, and retrieve them when cool.

COND: Given an equipped laboratory.

PL: Crucible lid should be placed beside the crucible, not on it. No contamination should occur from grease or disiccant, and the desiccator lid should be *carefully* removed and replaced to avoid breakage.

OBJ 5: Transport a crucible and lid in a desiccator.

COND: Given a desiccator, crucible, and lid.

PL: Lid must be held firmly and contents not disturbed during transport.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Desiccator	x	x	x	x	x			
Desiccant (e.g., silica gel)	x	x	x	x	x			
Towel		x	x					
Solvent (e.g., acetone)			x					
Stopcock grease			x					
Crucible and lid				x	x			
Tongs				x				

Muffle Furnaces

ENV SCI 101:1d(49)

PURPOSE

This guide will assist you in learning to use a muffle furnace to decompose a solid sample to give a constant weight. Many laboratory tests require heating at temperatures of 200° to 600°C in such a furnace.

PREREQUISITES

Before beginning this module you should have successfully completed Balances 101:1a, Desiccators 101:1c, and Ovens 101:1b.

RESOURCES

IRIS: 2911 (Module 13)

OBJECTIVES

OBJ 1: Identify the major features of a muffle furnace.

COND: Given the muffle furnace or pictures or sketches of it.

PL: Include:
- a. On-off switch
- b. Temperature control
- c. Temperature scale
- d. Pilot light
- e. Door handle
- f. Work shelf

OBJ 2: Operate a muffle furnace at a given temperature.

COND: Given the muffle furnace, resources, and the operations manual.

PL: Temperature must be ± 10°C of chosen value. (If the furnace has no standard scale, it may be necessary to standardize the furnace.)

OBJ 3: Add and remove a crucible from a hot furnace.

COND: Given an equipped laboratory and resources.

PL: Addition and removal should be done without breakage, contamination or burns.

OBJ 4: Heat a sample to constant weight.

COND: Given an equipped laboratory and resources.

PL: Three consecutive weighings should be within ± 0.4 mg of the correct weight.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Muffle furnace	x	x	x	x				
Crucible with lid			x	x				
Tongs			x	x				
Asbestos glove			x	x				
Desiccators			x	x				
Analytical balance				x				
Calcium bicarbonate [$Ca(HCO_3)_2$]				x				
Fume hood		x	x	x				

Hot Plates

ENV SCI 101:1e(49)

PURPOSE

This guide will assist you in learning to use the hot plate, which is the most commonly used electrical heating device in the laboratory. The hot plate is a simple and quick device for heating samples, but does not give a well controlled temperature. It is safer than an open flame for heating combustible materials.

PREREQUISITES

Before beginning this module you should be able to use a Celsius thermometer [Chem 101:46b(36)].

RESOURCES

IRIS: 2911 (Module 12)

OBJECTIVES

OBJ 1: Identify the major features of a hot plate.

COND: Given a hot plate or pictures or sketches of it.

PL: Include:

a. On-off control
*b. Stirrer speed control
c. Temperature control
d. Pilot light
e. Plate

OBJ 2: Calibrate the temperature control dial.

COND: Given an equipped laboratory and resources.

PL: Temperature should be reproducible to ± 5°C at 100°C.

OBJ 3: Boil a liquid sample on the hot plate.

COND: Given an equipped laboratory and resources.

PL: Water should boil smoothly at the setting corresponding to 100°C.

*Some hot plates include a magnetic stirrer.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Hot plate	x	x	x					
Celsius thermometer		x	x					
Mineral oil (high boiling point)		x	x					
Beaker (250 ml)		x	x					
Boiling stones			x					
Water			x					

Hoods

ENV SCI 101:1(49)

PURPOSE

This guide will assist you in learning how to use the hood to prevent accidents, since many tests generate gases or fumes that can harm both the experimenter and equipment.

PREREQUISITES

None

RESOURCES

IRIS: 2911 (Module 3)

OBJECTIVES

OBJ 1: Identify the major features of a fume hood.

COND: Given a hood or pictures or sketches of a hood.

PL: Include:

a. Sliding glass shield
b. Outlets and controls for gas, water, and air
c. Workbench top
d. Electrical outlet
e. Electrical on-off switch
f. Drain

OBJ 2: Operate the fume hood and each of the features of the hood.

COND: Given the hood, NH_4OH, beaker, and resources.

PL: All systems should work.

OBJ 3: Test for suction from the hood.

COND: Given the hood, matches, and resources.

PL: With hood switch on and the shield up, match should not go out. With the hood up about 5 cm, match should be blown out.

OBJ 4: Identify the kinds of procedures which should be carried out in the hood.

COND: Given a list of procedures, including ones involving noxious gases such as NO_2, H_2, and Cl_2

PL: All listed procedures requiring the hood must be identified.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Hood	x	x	x					
Ammonium hydroxide (NH_4OH)		x						
Beaker		x						
Matches			x					
List of procedures				x				

Water Stills

ENV SCI 101:1g(40)

PURPOSE

This guide will assist you in learning to use the water still and keep it in operation. Water stills provide water which is free of most of the chemicals found in tap water, and distilled water is necessary for most laboratory tests.

PREREQUISITES

None

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify the major features of a still.

COND: Given the still or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Water inlet
c. Condenser
d. Water drain
e. Safety valve
f. Storage container

OBJ 2: Operate and perform routine maintenance on a still.

COND: Given the still, resources, and the operations manual.

PL: Turn water on, turn switches on, adjust condenser water for smooth flow, check regularly, and clean when solids build up (this can decrease efficiency).

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Water still	x	x						

pH Meters

ENV SCI 101:1h(49)

PURPOSE

This guide will assist you in learning to adjust, operate, and care for a pH meter. The pH meter is a fast, accurate instrument for measuring the acidity (or basicity) and pH of a solution.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:2a and Chem 101:46b(36).

RESOURCES

IRIS: 404, 1063, 1762, 2110, 2122

OBJECTIVES

OBJ 1: Identify the major features of a pH meter.

COND: Given the pH meter or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Temperature adjust
c. Scale adjust
d. pH scale
e. pH electrode
f. Reference electrode
g. Electrode connectors
h. Stand-by knob

OBJ 2: Read the pH scale.

COND: Given the pH meter or pictures or sketches of it.

PL: Read to ± 0.01 unit.

OBJ 3: Standardize the pH meter.

COND: Given the pH meter, two buffer solutions, water, beakers, thermometer, and resources.

PL: Adjust for temperature and buffers to ± 0.01 pH unit, rinsing electrodes after each measurement.

OBJ 4: Determine the pH of a sample.

COND: Given the pH meter, two buffer solutions, beakers, water, thermometer, sample, and resources.

PL: Sample pH should be within ± 0.02 pH units of correct value.

OBJ 5: Clean the electrodes and prepare for temporary storage.

COND: Given the pH meter, beakers, distilled water, and dust cover.

PL: Electrodes should be rinsed and suspended in distilled water, dust cover left in place, and meter left "on stand-by" or "off."

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
pH meter	x	x	x	x	x			
Buffer solutions covering a range of 5 to 7 pH units			x	x				
Beaker			x	x	x			
Distilled water			x	x	x			
Thermometer			x	x				
Sample, with known pH				x				

Spectrophotometers

ENV SCI 101:1I(49)

PURPOSE

This guide will assist you in learning to use the spectrophotometer. Many chemical laboratory tests depend on the spectrophotometer to read accurately the intensity of color of a solution at a given wavelength.

PREREQUISITES

Before beginning this module you should be able to use laboratory glassware (beakers, test tubes, and graduated cylinders), and use metric volumes.

RESOURCES

IRIS: 850, 1061, 1062

OBJECTIVES

OBJ 1: Identify the major features of a spectrophotometer.

COND: Given the spectrophotometer or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Sample compartment
c. Cuvette
d. Absorbance and transmittance scales
e. Zero adjust
f. 100% adjust
g. Wavelength control
h. Photo tube
i. Filter

OBJ 2: Read the scales on the spectrophotometer.

COND: Given the spectrophotometer or pictures or sketches of it.

PL: Reading should be to ± 2% transmittance.

OBJ 3: Adjust the wavelength of a spectrophotometer.

COND: Given the spectrophotometer and a stated wavelength.

PL: Wavelength should be correct to within ± 1 unit.

OBJ 4: Zero the spectrophotometer.

COND: Given the spectrophotometer, a cuvette, water blank, resources, and operations manual.

PL: Zero should be reproducible to ± 2%.

OBJ 5: Adjust the 100% transmittance scale.

COND: Given the spectrophotometer, a cuvette, water, resources, and the operations manual.

PL: 100% mark should be reproducible to ± 2%.

OBJ 6: Read the absorbance and transmittance of a sample.

COND: Given the spectrophotometer, resources, a cuvette, water blank, a sample solution, the operations manual, and a wave length.

PL: Adjust the zero and 100% scales and the wavelength, then read to absorbance and transmittance to within ± 2% of the correct value.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Spectrophotometer	x	x	x	x	x	x		
Cuvette				x	x	x		
Distilled water				x	x	x		
Sample solution with known absorbance						x		

Autoclaves

ENV SCI 101:1J(49)

PURPOSE

This guide will assist you in learning to use and identify the component parts of the autoclave, which is used to sterilize equipment to be used in biological tests.

PREREQUISITES

None

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify the major features of an autoclave.

COND: Given the autoclave or pictures or sketches of an autoclave.

PL: Include:
- a. On-off switch
- b. Steam control
- c. Pressure gauge
- d. Safety valve
- e. Temperature control
- f. Temperature gauge
- g. Door latch
- h. Timer
- i. Shelves

OBJ 2: Use the autoclave to sterilize glassware.

COND: Given the autoclave, beakers, tongs, resources, and stated temperature, pressure, and time.

PL: Pressure gauges should record the necessary pressure to ± 5% and the necessary temperature to ± 5°C.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Autoclave	x	x						
Beaker		x						
Tongs		x						

Graduated Cylinders

ENV SCI 101:2a(49)

PURPOSE

This guide will assist you in learning when and how to use graduated cylinders, which are used to measure and transfer volumes of liquids quickly and with moderate accuracy.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 2105, 2911 (Module 8)

OBJECTIVES

OBJ 1: Identify the characteristic features of a graduated cylinder.

COND: Given a graduated cylinder or pictures or sketches of one.

PL: Include:
- a. Total volume
- b. Volume represented by each mark
- c. Approximate accuracy
- d. Statement of its use, in your own words

OBJ 2: Clean a graduated cylinder.

COND: Given a graduated cylinder, brush, detergent, rubber gloves, chromic acid cleaning solution, and distilled water.

PL: Water should drain smoothly from the walls, with no clinging droplets.

OBJ 3: Using the lower part of the meniscus, read the volume of liquid contained in a graduated cylinder.

COND: Given a graduated cylinder, water or pictures or sketches of these.

PL: ± 0.5 ml for 100 ml cylinder or smaller.

OBJ 4: Transfer a given volume of liquid using a 100 ml graduated cylinder.

COND: Given a graduated cylinder, water, and a stated volume to be transferred.

PL: ± 0.5 ml.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Graduated cylinders (volumes from 10 to 100 ml)	x	x	x	x				
Test tube brush		x						
Detergent		x						
Rubber gloves		x						
Chromic acid solution		x						
Distilled water		x	x	x				

Volumetric Flasks

ENV SCI 101:2b(49)

PURPOSE

This guide will assist you in learning when and how to use volumetric flasks. These are used to prepare solutions that require great accuracy and precise volumes, and they require more time to use than a graduated cylinder.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1a and Chem 101:37(35).

RESOURCES

IRIS: 2105, 2911 (Module 8)

OBJECTIVES

OBJ 1: Identify the characteristic features of volumetric flasks.

COND: Given volumetric flasks or pictures or sketches of them.

PL: Include:

a. Total volume
b. Temperature at which volume measurement is accurate
c. Approximate accuracy
d. Mark identifying total volume
e. Stopper or plug
f. Statement of its use, in your own words

OBJ 2: Clean a volumetric flask.

COND: Given a flask, distilled water, detergent, a brush, chromic acid solution, and rubber gloves.

PL: Water should drain smoothly from the walls, leaving no clinging droplets.

OBJ 3: Correctly fill a volumetric flask to the mark.

COND: Given the volumetric flask, water, and a medicine dropper.

PL: The bottom of the meniscus should occur at the mark in 3 consecutive tries.

OBJ 4: Prepare a solution of known concentration.

COND: Given the volumetric flask, a weighed sample of salt, water, and a medicine dropper.

PL: Procedures for dissolving, mixing, and adding liquid to mark should be demonstrated.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Volumetric flask (any volume from 25 to 1000 ml)	x	x	x	x				
Test tube brush		x						
Detergent		x						
Rubber gloves		x						
Chromic acid solution		x						
Medicine dropper or pipet			x	x				
Sodium chloride (NaCl)				x				
Balance				x				

Volumetric and Measuring Pipets

ENV SCI 101:2c(49)

PURPOSE

This guide will assist you in learning to use both volumetric and measuring (Mohr) pipets for laboratory tests in which specific volumes of liquids must be measured and transferred quickly and accurately to ± 0.01 ml.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 404, 2105, 2106, 2534, 2911 (Module 10)

OBJECTIVES

OBJ 1: Identify volumetric and measuring (Mohr) pipets and identify the major features of each.

COND: Given the pipets or pictures or sketches of them.

PL: Identify:

a. Volume represented by each mark
b. Total volume
c. Bulb
d. TD (to deliver) or TC (to contain)

OBJ 2: Transfer volumes of liquids with volumetric pipets.

COND: Given the pipets, beakers, water, a volumetric flask, and a bulb or aspirator.

PL: For 50 ml or less, the accuracy must be ± 0.05 ml.

OBJ 3: Transfer specific volumes of liquid with a pipet.

COND: Given the pipet, beakers, water, and a volumetric flask.

PL: Volumes, including fractions of ml, should be delivered to the nearest 0.05 ml. Technique should be evaluated by delivery into a standard solution with proper indicator.

OBJ 4: Clean pipets.

COND: Given pipets, beakers, water, detergent, chromic acid, rubber gloves, and resources.

PL: Water should drain cleanly, leaving no droplets clinging to the walls.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Volumetric pipet (5, 10, 20, 25 or 50 ml)	x	x		x				
Mohr pipet (5, 10, 20 or 25 ml)	x		x	x				
Volumetric flask (same volume as pipets)		x	x					
2 beakers (100 or 250 ml)		x	x	x				
Detergent				x				
Rubber gloves				x				
Chromic acid solution				x				

The Care and Use of Burets

ENV SCI 101:2d(49)

PURPOSE

This guide will assist you in learning to use the buret, which is needed in many laboratory tests that require the addition of liquids carefully, in small increments and accurate to ± 0.01 ml.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 285, 1143, 2105, 2127, 2911 (Module 9)

"How to Titrate Using a Buret," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Identify the characteristic features of burets.

COND: Given the buret or pictures or sketches of it.

PL: Include:

a. Barrel
b. Volume represented by each mark
c. Total volume
d. Tip
e. Type of stopcock, stating whether it is suitable for acid and alkaline solutions
f. Stopcock fastener

OBJ 2: Lubricate a glass stopcock.

COND: Given a buret with glass stopcock, stopcock grease, acetone, towels, and thin copper wire.

PL: Remove all old grease from the stopcock and lubricate with a thin layer of fresh stopcock grease. (There should be no grease in the tip; if there is, remove it.) Stopcock should turn smoothly without binding or slipping, and no grease should plug the hole.

OBJ 3: Read the volume of liquid in a buret.

COND: Given a buret, a beaker, and water.

PL: Read to ± 0.01 ml.

OBJ 4: Fill a buret and deliver a prestated volume of liquid.

COND: Given a buret, water and beakers, and a funnel.

PL: Fill without spilling and remove all air bubbles. Deliver accurately to ± 0.01 ml.

OBJ 5: Fill, zero, and deliver liquid accurately with an automatic buret.

COND: Given the buret, beakers, and water.

PL: Accurate to ± 0.01 ml.

OBJ 6: Perform a titration.

COND: Given burets, flasks, funnel, standard solution, an indicator, an "unknown" acid solution, and a procedure.

PL: Three consecutive titrations should vary no more than 0.01 ml. Each titration should require less than 10 minutes, including filling the burets.

OBJ 7: Clean burets.

COND: Given the glassware, buret brush, detergent, chromic acid, and rubber gloves.

PL: The glassware should drain clean, with no droplets of water clinging to the walls.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Buret: Glass stopcock	x		x	x		x	x	
Buret: Teflon or glass stopcock		x						
Buret: Automatic buret					x			
Stopcock grease		x						
Acetone		x						
Towels		x						
Copper wire (thin)		x						
2 beakers (250 ml)			x	x	x	x	x	
Funnel				x		x		
2 Erlenmeyer flasks (250 ml)						x		
Standard NaOH (0.100N)						x		
Sulfuric acid (H_2SO_4) solution (about 0.1N)						x		
Phenolphthalein						x		
Detergent							x	
Buret brush							x	
Chromic acid solution							x	
Rubber gloves							x	

Serial Dilution

ENV SCI 101: 3a (49)

PURPOSE

This guide will assist you in learning to perform a serial dilution on a water sample. This procedure is designed to reduce the quantity of a substance or microorganism to a level which may be determined easily. Quite often, when a dilution is not performed, the number of microorganisms or the concentration of a solution is too high to be determined by standard methods. A serial dilution will bring a sample within the normal range of analysis.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1(49) and 101:2(49)], and prepare reagents [Chem 101:47j(36)].

RESOURCES

IRIS: 1352

OBJECTIVES

OBJ 1: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory.

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried.
b. Pipets, plugged with cotton, sterilized one hour at 170°C.
c. Reagents correctly prepared.

OBJ 2: Perform a serial dilution.

COND: Given resources.

PL: Conditions as stated in resources must be met.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
9 test tubes	x	x						
Test tube rack		x						
0.1N hydrochloric acid (HCl)		x						
0.001N sodium hydroxide (NaOH)		x						
0.02% phenol red		x						
Paper labels		x						
Cotton		x						
8 1 ml pipets		x						
1 pipet bulb		x						
1 eyedropper		x						

Pouring Agar Plates

ENV SCI 101:3b(49)

PURPOSE

This guide will assist you in learning how to pour agar plates, using petri dishes. Petri dishes contain a top cover which overlaps a bottom cover. Air easily enters the dish, but the overlapping edge prevents contaminants from reaching the sterile medium within the dish. Petri dishes are most often used:

1. to observe surface and subsurface growths of bacterial colonies;
2. to isolate an individual bacterial colony from mixtures of colonies;
3. to maintain or cultivate species which require large surface area for growth.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1(49) and Env Sci 101:2(49)] and be able aseptically to prepare culture media [Env Sci 101:4(49)].

RESOURCES

1. "Pour Plate Technique for Isolation of a Pure Culture," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.
2. "How to Pour Agar Plates," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory.

PL: Include:

a. Six nutrient agar pours
b. Two beakers of hot water (50°C and 100°C)
c. Six sterile petri dishes
d. Refrigerator

OBJ 2: Aseptically prepare petri dish cultures.

COND: Given an equipped wastewater laboratory and Resource 1.

PL: All cultures should show no growth after incubation at 35°C.

OBJ 3: Pour agar plates.

COND: Given an equipped wastewater laboratory and resources.

PL: The pours should be prepared by melting at 100°C, cooling to 50°C, then incubating for 24 hours. No cultures should develop during this time.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
6 agar pours	x	x	x					
6 petri dishes	x	x	x					
2 1000 ml beakers	x	x	x					
Incubator 35°C		x	x					
Thermometer	x	x	x					
Bunsen burner		x	x					

Streaking Agar Slants and Plates

ENV SCI 101:3c(49)

PURPOSE

This guide will assist you in learning to perform streaking techniques aseptically. The streak plate and streak slant techniques are useful methods for:

1. separating a pure culture from a mixed culture;
2. lowering the population density of an organism;
3. determining if more than one type of organism is present in a dense culture.

PREREQUISITES

Before beginning this module you should be able to prepare and pour culture media [Env Sci 101:3b and f(49)] and be able to perform an aseptic transfer [Env Sci 101:3e(49)].

RESOURCES

(To be provided by instructc

OBJECTIVES

OBJ 1: Aseptically prepare four agar pours and two agar slants.

COND: Given an equipped wastewater laboratory and resources.

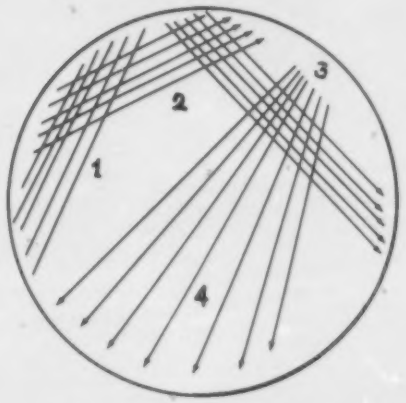
PL: Pours and slants should show no sign of growth after storage in the refrigerator for one day.

OBJ 2: Streak two pour plates using the Quadrant Streak Method.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Agar surface should not be gouged or broken.
b. Streaked plates should show isolated colonies which have been well separated.
c. Incubated culture should show only those organisms present in the original culture.
d. Pattern on the plates should appear as below:



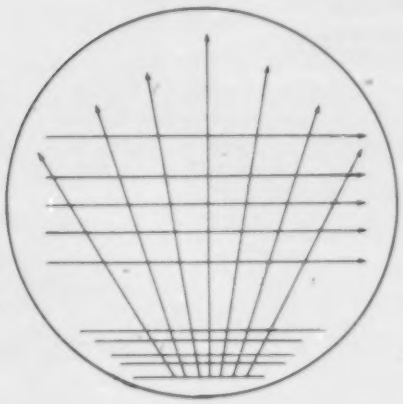
OBJ 3: Streak two pour plates using the Radient Streak Method.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Agar surface should not be gouged or broken.
b. Streaked plates should show isolated colonies which have been well separated.

c. Incubated culture should show only those organisms present in the original culture.
d. Pattern on the plates should appear as below:



OBJ 4: Streak two slants.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Agar surface should not be gouged or broken.
b. Streaked slant should show isolated colonies which have been well separated.
c. Incubated culture should show only those organisms present in the original culture.
d. Zig-zag pattern should appear on the surface of the agar.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
4 agar plates	x	x	x					
2 slants	x			x				
Inoculating loop		x	x	x				
Mixed culture broth		x	x	x				
Bunsen burner		x	x	x				
Test tube rack	x			x				
Incubator 37°C		x	x	x				
Refrigerator	x							

Aseptic Transfers with Loop

ENV SCI 101:3e(49)

PURPOSE

This guide will assist you in learning to perform pure culture transfers without adding outside contaminating bacteria or infecting yourself and contaminating the lab. Since microbes are present everywhere, it is necessary to use extreme care not to introduce unwanted organisms into a pure culture. Aseptic techniques are techniques which keep outside microorganisms from contaminating your transfer culture.

PREREQUISITES

None

RESOURCES

"The Use of Aseptic Techniques in the Tube Transfer of Bacteria," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Prepare the inoculating loop.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. Correctly holding the loop.
- b. Flaming the total wire portion to the loop to redness.
- c. Cooling the loop for about 30 seconds.

OBJ 2: Prepare the tubes for transfer.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. Correctly holding the tubes.
- b. Correctly removing the caps.
- c. Flaming the mouths for 2-5 seconds.

OBJ 3: Aseptically transfer a culture from one tube to another.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. Collecting a small amount of culture on the loop using a side-to-side motion.
- b. Avoiding gouging or otherwise penetrating the medium surface.
- c. Reflaming the tubes.
- d. Replacing the caps on the proper tubes.
- e. Reflaming the loop.
- f. Performing the exercise outlined in resources.
- g. Incubating the transferred culture to insure it is a pure culture of a single species.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
3 agar slants		x	x					
1 culture slant			x					
4 caps		x	x					
1 test tube rack		x	x					
Bunsen burner	x	x	x					
Inoculating loop	x		x					

Preparing Culture Media

ENV SCI 101:3(49)

PURPOSE

This guide will assist you in learning how to prepare tubes and plates of several different kinds of culture media which will be used in subsequent guides. A *medium* is the food used for culturing microorganisms. *Liquid media* (nutrient broth, glucose broth) can be used for fermentation studies (coliform by MPN), for growth of large numbers of organisms, and for numerous other procedures. *Solid media* (nutrient agar, nutrient gelatin) are used to assist in the isolation of pure cultures and to observe the appearance of surface organisms.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1 and 2(49)].

RESOURCES

1. "Pour Plate Technique for Isolation of a Pure Culture," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.
2. "How to Pour Agar Plates," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory.

PL: Include:
- a. Autoclave
- b. Water distillation apparatus
- c. Hot plate
- d. pH meter
- e. Balance

OBJ 2: Prepare glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. All glassware washed with detergent, rinsed with tap water and distilled water, and dried with air. (Do not towel dry.)
- b. Adjusted autoclave.
- c. Calibrated pH meter.

OBJ 3: Prepare a batch of nutrient agar.

COND: Given an equipped wastewater laboratory, resources, and the label on the dehydrated nutrient agar bottle.

PL: Include:
- a. Media will be prepared in the correct proportions by weight.
- b. pH will be adjusted.
- c. Agar will not char.
- d. Agar will be poured into test tubes by means of a dispensing funnel.

OBJ 4: Prepare a batch of nutrient broth.

COND: Given an equipped wastewater laboratory, resources, and the label on the dehydrated nutrient broth bottle.

PL: Include:

a. Media will be prepared in the correct proportions by weight.
b. pH will be adjusted.
c. Nutrient broth will be poured into test tubes with caps.

OBJ 5: Sterilize the media.

COND: Given an equipped wastewater laboratory and autoclave directions.

PL: Include:

a. Proper operation of the autoclave must be demonstrated, including necessary corrections for temperature and pressure.
b. Sterilized media should show no signs of growth after refrigeration for 48 hours.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Autoclave	x	x			x			
pH meter	x	x	x	x				
Water distillation apparatus	x	x	x	x				
Hot plate	x	x	x	x				
Balance	x	x	x	x				
Test tubes (20 mm diameter)		x	x	x	x			
Caps for test tubes		x	x	x	x			
Stirring rod		x	x	x				
Nutrient agar (dehydrated)			x					
Nutrient broth (dehydrated)				x				
Test tube wire basket			x	x	x			
Refrigerator					x			
Thermometer			x	x				

Counting Colonies and Making Total Counts

ENV SCI 101:3g and d(49)

PURPOSE

This guide will assist you in learning a method for determining the total number of living microorganisms in a sample. The total count is a gross indicator of overall bacteriological quality. The techniques involved are common to more specific water quality tests.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1 and 2(49)], be able to prepare and pour culture media [Env Sci 101:3b and f (49)], and be able to perform a serial dilution [Env Sci 101:3a(49)].

RESOURCES

IRIS: 1414

OBJECTIVES

OBJ 1: Perform a proper serial dilution on the practice sample.

COND: Given resources and an equipped wastewater laboratory.

PL: Conditions stated in IRIS 1414 must be met. Include:

a. Final result should be checked by indicator (only two solutions should be pink).
b. Correct numbering of dilutions.
c. Each dilution must be completely mixed.

OBJ 2: Perform a proper serial dilution on a tube of nutrient broth culture.

COND: Given an equipped laboratory.

PL: Include:

a. Each dilution must be completely mixed before it is used to make subsequent dilutions.
b. Each dilution must be labeled.
c. Conditions stated in resources must be met.
d. Cultures made from these dilutions and incubated at 37°C for 24-48 hours should show the effects of the dilution (i.e., there should be a gradient in population density with the greatest dilution showing the smallest population).

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
1 tube nutrient broth culture		x						
18 test tubes	x	x						
1 150 ml bottle with cap	x							
0.1N hydrochloric acid (HCl)	x							
0.001N sodium hydroxide (NaOH)	x							
0.02% phenol red	x							
Rubber suction bulb	x	x						
3 5 ml pipets	x	x						
18 1 ml pipets	x	x						
9 agar petri dishes		x						
Incubator 37°C		x						
Colony counter		x						

Bacteriological Sample Container Preparation

ENV SCI 101:4(49)

PURPOSE

This guide will assist you in preparing containers for bacteriological samples. Bacteriological samples must contain only those organisms associated with the source of the sample. Therefore, the sample container must be kept sterile until the sample is taken.

PREREQUISITES

Before beginning this module you should have successfully completed [Env Sci 101:1a and j(49)]; [Env Sci 101:2a-c(49)]; [Chem 101:46e and f(36)]; [Chem 101:47j (36)].

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Select and clean sample containers.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Bottle size at least 100 ml capacity. The following steps performed:

a. Bottle washed with detergent.
b. Rinsed with hot water.
c. No chipped, cracked, scratched or etched bottles or caps selected.
d. Rinsed with distilled or deionized water.

OBJ 2: Prepare 10% sodium thiosulfate solution.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Solution with 10% sodium thiosulfate ± 1%.

OBJ 3: Add sodium thiosulfate to sample bottle.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Thiosulfate added at rate of 0.1 ml ± 0.02 ml per 100 ml container.

OBJ 4: Cover stoppered bottle with covering material.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Not more than 2% of coverings fall off when turned upside down after autoclaving.

OBJ 5: Autoclave sample bottles.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Temperature maintained at 121°C for 15 minutes.

OBJ 6: Select marker and attach labels.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Marker must be a nonsmearing, permanent type. Labels must be clean and unused. A sharp tug on label should not detach it from bottle.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Autoclave, providing uniform temperatures up to and including 121°C.					x			
Balance, 0.1 g sensitivity at a load of 150 g		x						
Apron	x	x	x	x	x	x		
Bottles, sample, 250 ml wide mouth, glass stopper	x		x	x	x	x		
Jar (to receive used pipets)		x	x					
Pipets, 1 ml with 0.1 ml graduation (Mohr type)		x	x					
Pencils, china-marking, wax						x		
Metal foil or heavy paper or rubberized cloth, milk bottle cap				x	x	x		
Detergent	x							
Bottle brush	x							
Deionized or distilled water	x							
Labels and cord						x		
Volumetric flask, 100 ml		x						
Weighing dish		x						
Spatula		x						
Sodium thiosulfate ($Na_2S_2O_3$)		x						

Bacteriological Sample Collection

ENV SCI 101:5(50)

PURPOSE

This guide will assist you in learning the correct technique for collection of a bacteriological sample. Bacteriological samples must be representative of their source. Care must be taken that the sample is not contaminated during its collection.

PREREQUISITES

None

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Collect and check condition of sampling equipment.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:
- a. Sampling device
- b. Germicide for emergencies
- c. Rubber gloves
- d. Ice chest

OBJ 2: Select point for sample.

COND: Field location and resources (IRIS 2559).

PL: Include:
- a. Service line flushed for at least 3 minutes or until line clears.
- b. Direction of flow determined for stream.
- c. If no flow evident, position taken to minimize contamination.

OBJ 3: Take sample

COND: Given sample containers, sample location, and resources (IRIS 2559).

PL: Include:
- a. Bottle and cap not contaminated.
- b. Bottle 3/4 full.
- c. Labeled with required information.
- d. Top sealed with covering.
- e. Placed in ice chest.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Prepared sample bottles	x		x					
Germicide	x		x					
Rubber gloves	x		x					
Ice chest	x		x					
Sampling device	x		x					

Transporting and Storing of Bacteriological Samples

ENV SCI 101:6,7(50)

PURPOSE

This guide will assist you in learning how to correctly transport and store a bacteriological sample. Bacteriological samples must be transported and stored under proper conditions to assure validity of results. Time delays or warm temperatures will invalidate these results.

PREREQUISITES

None

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Describe the procedure for transporting to the laboratory and storing a bacteriological sample in the laboratory.

COND: Given resources (IRIS 2559).

PL: Include:

a. Desirable and maximum time from sampling to storage in laboratory.
b. Desirable and maximum time in storage before analysis.
c. Type of container for storage during transportation.
d. Temperature inside transporting container.

OBJ 2: Transport samples to laboratory.

COND: Given samples, equipment, and resources (IRIS 2559).

PL: 95% of samples arriving at the laboratory must be suitable for analysis.

OBJ 3: Store samples.

COND: Given samples, equipment, and resources (IRIS 2559).

PL: 95% of samples stored must be suitable for analysis.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Samples		x	x					
Ice chest		x						
Refrigerator (2^{o}-10^{o}C)			x					

Selection of Sample Locations for Bacteriological Analysis

ENV SCI 101:8(50)

PURPOSE

This guide will assist you in learning how to select sample locations for bacteriological analysis. Process control or legal requirements dictate that bacteriological samples be analyzed from a number of locations.

PREREQUISITES

None

RESOURCES

1. Plant operational guide
2. NPDES permit

OBJECTIVES

OBJ 1: Select appropriate sample location in a treatment plant or on watercourse for bacteriological samples.

COND: Given Resource 1 and Resource 2, and the reason for sample, including:

a. Determining efficiency of process.
b. Meeting a regulatory requirement.
c. Meeting a process requirement.

PL: Include:

a. Location in plant or on watercourse.
b. Location in process unit.
c. Location on watercourse cross section.
d. Depth.

EQUIPMENT AND SUPPLIES

None

Fecal Coliform Analysis

ENV SCI 101:9 and 10(50-51)

PURPOSE

This guide will assist you in performing the multiple dilution tube method for fecal coliform analysis, the test procedure acceptable to the U.S. Environmental Protection Agency.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Air incubator
b. Incubator waterbath
c. Oven, hot air
d. Water distillation apparatus
e. Autoclave
f. pH meter
g. Balance

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried.
b. Pipets, plugged with cotton, sterilized one hour at 170°C.
c. Dilution water blanks.
d. Lactose broth.
e. EC broth
f. Laboratory data sheets

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory, resources (IRIS 2559), and samples.

PL: Include:

a. Labeling culture tubes.
b. Filling out data sheet.
c. Disinfecting lab bench before and after inoculation.
d. Inoculating of tubes.
e. Placing racks in incubator.
f. Cleaning glassware.

OBJ 4: Tabulate results after 24 hours ± 2 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Readings made within 24 ± 2 hours.
b. Proper incubation temperature and humidity in incubator.
c. Tubes shaken before reading.
d. Gas production evaluated.

OBJ 5: Transfer positive samples at 24 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. EC broth tubes labeled, data recorded.
b. Sterile transfer made.
c. Lactose tubes returned to 35°C incubator.
d. EC tubes placed in waterbath incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after.

OBJ 6: Transfer positive samples at 48 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Readings made within 24 ± 2 hours.
b. Proper incubation temperature and humidity in incubator.
c. Tubes shaken before reading.
d. Gas production evaluated.
e. EC broth tubes labeled, data recorded.
f. Sterile transfer made.
g. Lactose tubes returned to 35°C incubator.
h. EC tubes placed in waterbath incubator.
i. Used glassware sterilized and cleaned.
j. Disinfection of lab bench before and after.

OBJ 7: Read EC broth tubes.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Recording data.
b. Tubes shaken before reading.
c. Gas production evaluated.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after.

OBJ 8: Describe and perform the data analysis.

COND: Given laboratory data and MPN code sheets.

PL: 90% calculated correctly.

a. MPN
b. Geometric mean

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Air incubator, 35°C ± 0.5°C	x		x	x	x	x		
Incubator, waterbath to operate at 44.5° ± 2°C	x				x	x	x	
Oven, hot-air sterilizing, 160°-180°C	x	x	x					
Water distillation apparatus	x	x	x					
Autoclave, 121°C	x	x	x		x	x	x	
pH meter, accurate 0.1 pH unit	x	x						
Balance, 0.1g sensitivity at load of 160g	x	x						
Apron or lab coat		x	x	x	x	x	x	
Baskets, wire		x	x		x	x	x	
Bottles, dilution, 6 oz. screw caps with 99 ml line		x	x					
Bottle squeeze type		x	x					
Burner, gas Bunsen		x	x		x	x		
Cans, pipet, aluminum		x	x					
Metal caps, for 20 x 150 ml tubes		x	x					
Jar		x	x					
Inoculation 100, 3 mm diameter		x	x		x	x		
Pipets, 1 ml with 0.1 ml gradation (Mohr type)		x	x					
Racks, culture types 10 x 5 openings		x	x	x	x	x	x	
Sponge		x	x	x	x	x	x	
Tubes, culture 150 x 18 mm		x	x	x	x	x	x	

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Tubes, fermentation, 75 x 10 ml vials		x	x	x	x	x	x	
Distilled water		x	x		x	x	x	
EC broth		x	x		x	x		
Lactose lauryl sulfate tryptose broth		x	x					
Potassium dihydrogen phosphate (KH_2PO_4)		x	x					
Disinfectant		x	x	x	x	x	x	
Wax pencils (Blaisdell 169T)		x	x		x	x		
Data sheets		x	x	x	x	x	x	x
MPN code sheets								x

Fecal Streptococcal Analysis

ENV SCI 101:9 and 10(50-51)

PURPOSE

This guide will assist you in learning how to conduct the fecal streptococcal test. Fecal streptococci are pathogenic and common to animals and man, and thus are indicators of fecal contamination. This test is often used in conjunction with other tests for fecal organisms as an indicator of contamination.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Air incubator
b. Oven, hot air
c. Water distillation apparatus
d. Autoclave
e. pH meter
f. Balance

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried
b. Pipets plugged with cotton, sterilized one hour at 170°C
c. Dilution water blanks
d. Azide dextrose broth
e. Ethyl videt azide broth
f. Inoculating loops
g. Pipet cans
h. Fermentation tubes
i. Sample bottles
j. Detergent
k. Distilled water
l. Water
m. Kraft paper
n. String
o. Dilution water
p. Data sheets
q. Marking pencil
r. Disinfectant
s. Sponge
t. Racks (test tube)

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Labeling culture tubes.
b. Filling out data sheet.
c. Disinfecting of lab bench. before and after inoculation.
d. Inoculation of tubes.
e. Placing racks in incubator.
f. Used glassware sterilized and cleaned.

g. Disinfection of lab bench before and after procedure

OBJ 4: Tabulate results after 24 hours ± 2 hours and 48 hours ± 3 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Evaluation of turbidity in tubes.
b. Recording data.

OBJ 5: Transfer positive samples.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer of sample to ethyl violet azide broth.
b. Second transfer if no growth at 24 ± 2 hours.
c. Incubate samples at 35 ± 0.5°C.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure

OBJ 6: Read ethyl violet azide broth tubes.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Read tubes.
b. Record data.
c. Used glassware sterilized and cleaned.
d. Disinfection of lab bench before and after procedure.

OBJ 7: Describe and perform the data analysis.

COND: Given lab data, MPN code sheets.

PL: 90% of MPN's calculated correctly.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Air incubator	x							
Oven, hot air	x							
Water distillation apparatus	x							
Autoclave	x							
pH meter	x							
Balance	x							
Dilution bottles		x	x					

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Sample bottles		x	x					
Fermentation tubes		x	x		x	x		
Soap		x	x		x	x		
Water		x	x		x	x		
Distilled water		x	x		x	x		
Cotton		x						
Kraft paper		x						
String		x						
Pipet cans		x	x					
Dilution water		x	x					
Inoculating loops		x	x		x			
Data sheets		x	x	x	x	x	x	
Marking pencils		x	x		x	x		
Disinfectant		x	x		x	x		
Sponge		x	x		x	x		
Racks (test tube)		x	x		x	x		
Azide dextrose broth		x	x					
Ethyl violet azide broth		x			x			

Total Coliform (MPN) Test

ENV SCI 101:9 and 10

PURPOSE

This guide will assist you in learning to perform a total coliform test, which is often used to determine the bacteriological quality of drinking water. It gives an indication of the possible contamination of the water by animal and human feces.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources.

PL: Include correct check of:

a. Air incubator
b. Oven, hot air
c. Water distillation apparatus
d. Autoclave
e. pH meter
f. Balance
g. Colony counter
h. Microscope

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried:
   1. dilution bottles and tubes
   2. petri dishes
   3. fermentation tubes and vials
   4. sample bottles
   5. glass slides
b. Glassware plugged, wrapped or canned, and sterilized one hour at 170°C
c. Dilution water
d. Lactose broth
e. Lauryl tryptose broth
f. Brilliant green lactose bile broth
g. Endo agar
h. EMB agar
i. Nutrient agar
j. Inoculating equipment
k. Pipet containers
l. Hucker's solution
m. Lugol's solution
n. Counter stain
o. Acetone, alcohol
p. Laboratory data sheets

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory, resources, and samples.

PL: Include:

a. Labeling culture tubes.
b. Filling out data sheet.
c. Disinfecting lab bench before and after inoculation.
d. Inoculating tubes.

e. Placing racks in incubator.
f. Cleaning glassware.

OBJ 4: Tabulate results after 24 hours ± 2 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Readings made within 24 hours ± 2 hours.
b. Proper incubation temperature and humidity in incubator.
c. Tubes shaken before reading.
d. Gas production evaluated.

OBJ 5: Transfer positive samples at 24 ± 2 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Broth tubes read, data recorded.
b. Sterile transfer made to brilliant green lactose bile.
c. Broth tubes returned to incubator.
d. Brilliant green tubes placed in 35°C incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after transfer.

OBJ 6: Transfer positive samples at 48 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Broth tubes read, data recorded.
b. Sterile transfer made to brilliant green lactose bile.
c. Broth tubes returned to incubator.
d. Brilliant green tubes placed in 35°C incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after transfer.

OBJ 7: Streak Endo or EMB plates.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Sterile transfer of sample.
b. Streaking plate.
c. Incubate plates at 35°C.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure.

OBJ 8: Prepare cultures for gram stain.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer typical colonies to broth and nutrient agar slant.
b. Incubate 35°C for 24 or 48 hours.
c. Used glassware sterilized and cleaned.
d. Disinfection of lab bench before and after procedure.

OBJ 9: Carry out gram stain.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer growth to distilled water and fix.
b. Stain and counter stain.
c. Examine under microscope.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure.

OBJ 10: Describe and perform data analysis.

COND: Given laboratory data, MPN code sheets, and resources.

PL: 90% of MPN's calculated correctly.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES									
	1	2	3	4	5	6	7	8	9	10
Air incubator	x	x	x	x	x	x	x	x		
Oven, hot air	x	x	x	x	x	x	x	x		
Water distillation apparatus	x	x								
Autoclave	x	x	x	x	x	x	x	x		
pH meter	x	x								
Balance	x	x								
Colony counter	x	x						x	x	
Microscope	x	x							x	
Dilution bottles and tubes		x	x							
Petri dishes		x					x			
Fermentation tubes and vials		x	x	x						
Sample bottles		x	x							
Soap		x	x	x	x	x	x	x	x	
Water		x	x	x	x	x	x	x	x	
Distilled water		x	x	x	x	x	x	x	x	
Cotton		x								
Kraft paper		x								
String		x								

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES									
	1	2	3	4	5	6	7	8	9	10
Pipet cans		x	x							
Petri dish cans		x								
Dilution water		x	x							
Lactose broth		x	x					x		
Lauryl tryptose broth		x	x							
Brilliant green lactose broth		x								
Endo agar		x					x			
EMB agar		x					x			
Nutrient agar		x						x		
Inoculating equipment		x	x	x	x	x	x	x	x	
Hucker's solution		x							x	
Lugol's solution		x							x	
Counter stain		x							x	
Acetone, alcohol		x							x	
Data sheets		x	x	x	x	x	x	x	x	x
Marking pencil		x	x		x	x		x		
Disinfectant			x		x	x	x	x	x	
Sponge			x		x	x	x	x	x	
Racks (test tube)		x	x		x	x			x	
Glass slides									x	

Trouble-Shooting Bacteriological Analysis

ENV SCI 101:11(51)

PURPOSE

This guide will assist you in learning to handle problems which often arise in many bacteriological samplings and laboratory analyses.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-10(49-51).

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Recognize an abnormal condition in any of the above procedures and suggest and take the action necessary to correct the abnormal condition.

COND: Given resources, laboratory data sheets, and plant logs.

PL: 80% of abnormal conditions must be recognized and corrected, including:

a. Unsatisfactory preparation of sampling containers and glassware.
b. Solution not standardized.
c. Nonsterile conditions.
d. Faulty weighing, pipetting, heating, covering containers, marking, incubation, reading gas production, recording data, calculations, use of equipment.
e. Improper sample sites selected.
f. Samples taken, transported or stored incorrectly.

EQUIPMENT AND SUPPLIES

All required in Env Sci 101:4-10(49-51).

Biochemical Oxygen Demand (BOD)

ENV SCI 102(1):1-8(69-71)

PURPOSE

This guide will assist you in determining the biochemical oxygen demand (BOD) of any water or wastewater. The BOD test is widely used to:

1. measure the dissolved oxygen that would be consumed if a wastewater were discharged into a natural body of water;
2. measure the efficiency of a wastewater process by determining how much BOD it removes;
3. measure the BOD of a natural stream.

PREREQUISITES

Before beginning this module you should have successfully completed DISSOLVED OXYGEN (DO), Env Sci 102(2):1-8(69-71).

RESOURCES

IRIS: 4, 540, 1413, 2558, 2559
NPDES
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for BOD samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate BOD sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a BOD sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter

f. Collection of a representative sample
g. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a BOD sample to the laboratory.

COND: Given resources (IRIS 4) and the interval up to 6 hours from the time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:
a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a BOD sample.

COND: Given resources (IRIS 4) and the interval up to 6 hours during which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be prepared according to IRIS 4 and must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a BOD analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time. Following items must be included:
a. List the following reagents and state their use in the sequence of the analysis:
1. potassium dihydrogen phosphate
2. dipotassium hydrogen phosphate
3. disodium hydrogen phosphate heptahydrate
4. ammonium chloride
5. magnesium sulfate heptahydrate
6. anhydrous calcium chloride
7. ferric chloride hexahydrate
8. concentrated sulfuric acid
9. potassium dichromate
b. List this equipment:
1. trip balance
2. still
3. incubator
c. List these analytical supplies:
1. glass stoppered bottles
2. weighing boats
3. 3-liter jug
4. plunger type mixer
5. beakers
6. graduated cylinders
7. volumetric flasks
8. pipets
d. Describe routine procedures for recording data.
e. Describe the calculations (in mg/l) for BOD content.
f. Prepare and standardize the necessary reagents.
g. Describe safety procedures.
h. Determine the BOD content of each sample provided.

OBJ 7: Report and interpret the BOD results using established technical report form.

COND: Given resources (IRIS 4) and typical BOD curves and data.

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results must be interpreted by performing the following:

a. Calculate the BOD for each day.
b. Plot a graph of BOD (mg/l) versus time (days) for each dilution and use it to estimate the best value for BOD_5 for that dilution.
c. Calculate the efficiency of the wastewater process in its removal of BOD.
d. Evaluate the technique using the standard BOD solution in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given laboratory control guide for plant in question, typical BOD curves and data, laboratory logbooks, and a calculator.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:
a. Oxidizing agents
b. Reducing agents
c. Nitrates
d. Organic compounds
e. Ferric salts
f. Suspended solids
g. Highly colored waters

Include:
a. Compare two values for the BOD_5 of the influent.
b. Compare two values for the BOD_5 of the effluent.
c. Justify BOD_5 values.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Air incubator or water bath (20°C)						x		
Dissolved oxygen apparatus						x		
BOD bottles (24 250ml)						x		
Dissolved oxygen reagents						x		
Distilled water						x		
Sealed bottles (2 500ml)	x	x	x		x	x		
Air pump or source of oil free						x		
Compressed air source with bubbler tube						x		
16-gallon nalgene container						x		

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Sample carrier				x				
Refrigerator				x		x		
Potassium dihydrogen phosphate (KH_2PO_4)						x		
Dipotassium hydrogen phosphate ($K_2H\ PO_4$)						x		
Disodium hydrogen phosphate ($Na_2HPO_4 \cdot 7H_2O$)						x		
Ammonium chloride (NH_4Cl)						x		
Magnesium sulfate ($MgSO_4 \cdot 7H_2O$)						x		
Calcium chloride ($CaCl_2$)						x		
Ferric chloride ($FeCl_3 \cdot 6H_2O$)						x		
Sodium hydroxide (NaOH)						x		
Hydrochloric acid (HCl)						x		
Sodium bisulfite ($NaHSO_3$)				x	x	x		

Dissolved Oxygen (DO)

ENV SCI 102 (2):1-8(69-71)

PURPOSE

This guide will assist you in determining the dissolved oxygen level (DO) of any water or wastewater. The dissolved oxygen determination is one of the most important tests in water quality control because:

1. it serves as the basis of the biochemical oxygen demand (BOD) test which measures the oxygen demand of organic material in water;
2. it tells how much dissolved oxygen is available for the respiration of the organisms in the water.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37).

RESOURCES

IRIS: 4, 540, 1413, 2558, 2559
NPDES
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for DO samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate DO sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Selection must include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a DO sample.

COND: Given resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequence
e. Absence of floating material
f. Collection of a representative sample

g. Labeling of container to show date, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a DO sample to the laboratory.

COND: Given resources (IRIS 4) and the interval from time of sampling to time of analysis, usually less than 30 minutes.

PL: 95% of samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a DO sample.

COND: Given resources (IRIS 4) and the time interval over which the sample must be kept in the laboratory, usually less than 30 minutes.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a DO analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time. The following items must be included:

a. List the following reagents and explain their roles in the analysis:
   1. manganous sulfate solution
   2. alkali-iodide-azide reagent
   3. concentrated sulfuric acid
   4. starch solution
   5. standard sodium thiosulfate titrant, 0.0250N
   6. standard potassium dichromate solution, 0.0250N
   7. potassium iodide, crystals
   8. potassium fluoride solution
b. List this equipment:
   1. analytical balance
   2. water still
c. List these analytical supplies:
   1. volumetric flasks
   2. beakers
   3. BOD bottles with stoppers, 300 ml
   d. burets
   5. buret support, clamps and caps
   6. pipets
   7. graduated cylinders
d. Explain the titration procedure and describe the end point.
e. Describe routine procedures for recording data.
f. Describe the calculations (in mg/l) for dissolved oxygen content.
g. Prepare and standardize the necessary reagents.
h. Describe safety procedures.
i. Determine the DO content of each sample provided using the iodometric method.

OBJ 7: Report and interpret the DO results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct, and 80% of interpretations must conform to those in resources. Results must be interpreted by:

a. Calculating the DO for each sample.

b. Comparing the DO with results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4), laboratory control guide for plant in question, typical DO data, laboratory notebooks, and a calculator.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:
a. Oxidizing agents
b. Reducing agents
c. Nitrates
d. Organic compounds
e. Ferric salts
f. Suspended solids
g. Highly colored waters

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Buret						x		
Buret clamp						x		
Ring stand						x		
Funnel						x		
200 ml volumetric flask						x		
Analytical balance						x		
1 liter volumetric flask			x					
1 liter beaker (2)			x					
Filter paper			x					
500 ml Erlenmeyer flask						x		
10 ml graduated cylinder			x					
BOD bottles (4 250 ml)	x	x	x					
Stirring rod			x					

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Hot plate			x					
Distilled water			x					
Sample carrier				x				
Manganese sulfate ($MnSO_4 \cdot 4H_2O$ or $MnSO_4 \cdot 2H_2O$ or $MnSO_4 \cdot H_2O$)			x					
Sodium hydroxide (NaOH or KOH)			x					
Sodium iodide (NaI or KI)			x					
Sodium azide (NaN_3)			x					
Concentrated sulfuric acid (H_2SO_4)			x					
Starch ($C_6H_{10}O_5$)						x		
Sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$)						x		
Potassium dichromate ($K_2Cr_2O_7$)						x		
Potassium fluoride ($KF \cdot 2H_2O$)						x		
Toluene (C_7H_8)			x					

Chemical Oxygen Demand (COD)

ENV SCI 102(3):1-8(69-71)

PURPOSE

This guide will assist you in determining the chemical oxygen demand (COD) of any water or wastewater. The COD test measures the total organic content that can be oxidized (usually to carbon dioxide and water) by potassium dichromate in a sulfuric acid solution. The main limitations of COD are that it does not reveal whether the organic matter is biodegradable or nonbiodegradable, and it gives no idea of the rate at which biologically active material (waste) would be stabilized in a receiving stream. These limitations are often compensated for by the fact that COD will always be greater than or equal to BOD and may be run in 3 hours as compared to the 5 days required by BOD.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47f,j(36-37); and Env Sci 101: 1e(49).

RESOURCES

IRIS: 4, 539, 557, 2558, 2559
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for COD samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate COD sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a COD sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed

c. Time of day
d. Frequency
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a COD sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from the time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a COD sample.

COND: Given resources (IRIS 4) and the interval (up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a COD analysis, including proper safety procedures.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation, as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. Prepare or obtain a list of chemicals, equipment, and analytical supplies needed to perform the dichromate method for COD analysis.
b. Describe the safety procedures for preparing silver sulfate-sulfuric acid solution.
c. Explain how these safety precautions protect the employee.
d. Name the two major steps in the dichromate procedure (refluxing and titration).
e. Describe the end point in the titration procedure.
f. Describe the routine procedures for recording data.
g. Set up equipment for titration.
h. Prepare and standardize the reagents.
i. Describe safety procedures.
j. Prepare a sample and a blank for the reflux condenser.
k. Perform the dichromate titration for COD analysis on a sample from one of the plant locations and report for the blank.
l. Record data and calculate the COD for each sample.

OBJ 7: Report and interpret the COD results using established technical report form.

COND: Given resources (IRIS 4) and typical COD curves and data.

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results must be interpreted by:

a. Calculating the COD for each sample.
b. Comparing the COD with results of other groups performing the same analysis.

c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given laboratory control guide for plant in question, typical COD curves and data, laboratory logbooks, and a calculator.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Aromatic hydrocarbon
b. Chlorides
c. Fatty acids
d. Ferrous iron
e. Nitrates
f. Pyridine
g. Sulfides

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Erlenmeyer flask (24/40 250ml)						x		
Buret						x		
Liebig condenser (24/40 joint)						x		
Hot plate						x		
Glass boiling beads						x		
500ml bottle (2)	x	x						
Volumetric flask (1 liter)						x		
Sample carrier				x				
Sulfuric acid (H_2SO_4)						x		
Potassium dichromate ($K_2Cr_2O_7$)						x		
Silver sulfate (Ag_2SO_4)						x		
Ferrous ammonium sulfate [$Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$]						x		
Mercuric sulfate ($HgSO_4$)						x		
Sulfamic acid						x		
1-10-phenanthroline monohydrate						x		

Total Dissolved Solids, Total Suspended Solids, Total Volatile Solids, and Total Solids

ENV SCI 102(4-7):1-8(69-71)

PURPOSE

This guide will assist you in performing four different solids tests on any water or wastewater. The solids tests measure the total amount of solid that may be found in any water sample and classify them according to whether they are dissolved, suspended or volatile. Solids in waters can cause an unpleasant taste and might produce sickness in people who are not accustomed to drinking them. The main limitations of the four solids tests are:

1. obtaining a representative sample;
2. difficulty of drying to constant weight in a reasonable time, especially when solids are high in oil or grease;
3. losses of volatile materials and carbon dioxide during muffle furnace ignition;
4. losses of volatile compounds during evaporation.

PREREQUISITES

Before beginning this module, you should have successfully completed Chem 101:46b, f(36) and 47a,j(36-37); and Env Sci 101: 1a,b,c,d(49).

RESOURCES

IRIS: 4, 902, 1370, 2559
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for RESIDUE (SOLIDS) ANALYSIS samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate RESIDUE (SOLIDS) ANALYSIS sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a RESIDUE (SOLIDS) ANALYSIS sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency
e. Removal of floating matter
f. Collection of a representative sample
g. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a RESIDUE (SOLIDS) ANALYSIS sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a RESIDUE (SOLIDS) ANALYSIS sample.

COND: Given resources (IRIS 4) and the interval (up to 7 days) during which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform each one of four RESIDUE (SOLIDS) ANALYSES, including proper safety procedure.

COND: Given resources (IRIS 4), and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the equipment appropriate to the solids test performed:
   1. balances
   2. muffle furnace
   3. crucible tongs
   4. desiccator
   5. gooch crucible
   6. gravity oven
   7. steambath
b. List these analytical supplies:
   1. evaporating dish
   2. glass filter disk
   3. suction flask
   4. crucible holder
   5. wash bottle
   6. graduated cylinders
c. Describe routine procedures for recording data.
d. Describe safety procedures.
e. Describe the calculations (in mg/l) for solids content.
f. Determine the solids content of each sample.

OBJ 7: Report and interpret the RESIDUE (SOLIDS) ANALYSIS using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results must be interpreted by:

a. Calculating TS, TDS, TVS, and TSS values.
b. Comparing the values with the results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including errors resulting from:

a. Volatile compounds lost during evaporation.
b. Carbon dioxide lost during ignition.
c. Calcium oxide produced during ignition and remaining in the ash.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Analytical balance						x		
Muffle furnace (550°C)						x		
Crucible tongs						x		
Desiccator						x		
Gravity oven (105°C)						x		
Steam bath						x		
Evaporating dish (50 ml)						x		
Glass filter disk (2.1 cm)						x		
Suction flask (500 ml)						x		
Crucible holder						x		
Wash bottle						x		
Graduated cylinder (50 ml)						x		
Graduated cylinder (100 ml)						x		
1 liter bottle	x		x					
Sample carrier				x				
Gooch crucible						x		

Residual Chlorine and Chlorine Demand

ENV SCI 102(8):1-8(69-71)

PURPOSE

This guide will assist you in determining the residual chlorine and the chlorine demand of a water sample. The residual chlorine test is widely used to:

1. calculate the chlorine demand;
2. calculate the proper amount of chlorine to apply so as to insure effective disinfection without waste of chlorine;
3. estimate the type of chlorination equipment needed by a water facility.

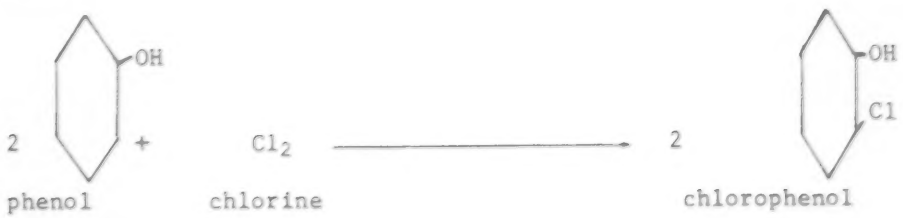
Chlorine is typically applied in the form of free chlorine or calcium hypochlorites. These forms of chlorine are strong oxidizing agents, and they react with a wide variety of impurities and substances in water. Side reactions of this type use up much of the chlorine before it can accomplish the disinfection intended. Chlorine demand is defined as the amount of chlorine necessary to satisfy the demand of various substances and impurities in water before actual disinfection can take place. The equations below indicate some of these demands:

NH_3 (ammonia) + HOCl (hypochlorous acid) → NH_2Cl (monochloramine) + H_2O

NH_2Cl (monochloramine) + HOCl (hypochlorous acid) → $NHCl_2$ (dichloramine) + H_2O

$NHCl_2$ (dichloramine) + HOCl (hypochlorous acid) → NCl_3 (trichloramine) + H_2O

H_2S (hydrogen sulfide) + $4Cl_2$ (chlorine) + H_2O → H_2SO_4 (sulfuric acid) + 8HCl (hydrochloric acid)



phenol — chlorine — chlorophenol

Studies indicate that the chloramines (also called combined chlorine residuals) are capable of some disinfection, although they are not as effective as the free chlorine residuals (Cl_2, HOCl, and OCl). The chlorine demand of a water sample is found by subtracting the total residual chlorine (both free and combined) from the amount of chlorine applied.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47f,j(36-37).

RESOURCES

IRIS: 4, 142, 556, 2558, 2559
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for residual chlorine samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate residual chlorine sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:
a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a residual chlorine sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:
a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of container to show date, place, time and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a residual chlorine sample to the laboratory.

COND: Given resources (IRIS 4), and the proper interval from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis

in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a residual chlorine sample.

COND: Given resources (IRIS 4) and the proper interval over which the sample may be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a residual chlorine and chlorine demand analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the following reagents and explain their roles in the analysis:
   1. standard sodium thiosulfate
   2. potassium dichromate
   3. potassium iodide
   4. acetic acid
   5. sulfuric acid
   6. starch
   7. sodium arsenite
   8. ammonium solution
b. List this equipment:
   1. water still
   2. pH meter
   3. analytical balance
c. List these analytical supplies:
   1. brown glass reagent bottles
   2. volumetric flasks
   3. burets and buret caps
   4. pipets and pipet bulb
   5. Erlenmeyer flasks
   6. graduated cylinders
d. Prepare and standardize the necessary reagents.
e. Describe safety procedures.
f. Determine the chlorine content of each sample provided using the starch-iodide method.

OBJ 7: Report and interpret the residual chlorine and chlorine demand results using established technical report form.

COND: Given resources (IRIS 4) and the amount of chlorine applied.

PL: 90% of results must be correct and 80% of interpretations must conform to those in resources. The results must be interpreted by:

a. Calculating the residual chlorine for each sample.
b. Calculating the chlorine demand for each sample.
c. Comparing these values with acceptable values.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given laboratory control guide for plant in question, laboratory logbooks, and a calculator.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Ferric ion
b. Manganese ion
c. Nitrite ion
d. Color and turbidity

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml Erlenmeyer flasks (2)		x	x			x		
50 ml buret						x		
Analytical balance						x		
Single pan balance						x		
Sample carrier	x	x	x	x				
Starch						x		
Potassium iodide (KI)						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		
Potassium dichromate ($K_2Cr_2O_7$)						x		
Iodine (I_2 resublimed)						x		
Acetic acid (glacial)						x		

Nitrogen (Organic)

ENV SCI 102(10):1-8(69-71)

PURPOSE

This guide will assist you in determining the organic nitrogen in drinking, surface, and saline waters, and domestic and industrial wastes. The organic nitrogen is determined by subtracting the nitrogen (ammonia) value [Env Sci 102(12):1-8(69-71)] from the Kjeldahl nitrogen value [Env Sci 102(11):1-8(69-71)].

PREREQUISITES

Before beginning this guide you should have successfully completed Chem 102(57); Env Sci 101:1,2(49); Env Sci 102(12):1-8 (69-71); and Env Sci 102(11):1-8(69-71).

RESOURCES

IRIS: 4

"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Calculate the organic nitrogen by subtracting the nitrogen (ammonia) value [Env Sci 102(12):1-8(69-71)] from the Kjeldahl nitrogen value [Env Sci 102 (11):1-8(69-71)].

COND: Given the data from the nitrogen (ammonia) and Kjeldahl nitrogen test.

PL: Three consecutive correct values must be obtained.

EQUIPMENT AND SUPPLIES

None

Kjeldahl Nitrogen

ENV SCI 102(11):1-8(69-71)

PURPOSE

This guide will assist you in determining the total Kjeldahl nitrogen in drinking, surface, and saline waters, and domestic and industrial wastes. The Kjeldahl method destroys the organic portion of nitrogen compounds by oxidation and frees the nitrogen as ammonia. This ammonia, along with any free ammonia already present in the sample, is measured by Nesslerization, or by titrimetry or potentiometrically. A disadvantage of the method is that it might not completely oxidize such industrial wastes as amines, nitro compounds, hydrazones, oximes, semicarbazones, and some refractory tertiary amines.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 102(57) and Env Sci 101:1,2(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for Kjeldahl nitrogen samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 100% of the sample containers must meet the specifications in IRIS 4, including no beads of water will be evident.

OBJ 2: Select appropriate Kjeldahl nitrogen sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Selection must include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a Kjeldahl nitrogen sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 100% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day

d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a Kjeldahl nitrogen sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (as soon as possible, but up to 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a Kjeldahl nitrogen sample.

COND: Given resources (IRIS 4) and the time interval (as soon as possible, but up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a Kjeldahl nitrogen analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List this equipment:
   1. Kjeldahl digestion apparatus
   2. ion exchange column
   3. pH meter
   4. spectrophotometer
b. List these analytical supplies:
   1. Kjeldahl flask (800 ml)
   2. condenser
   3. condenser adapter
   4. glass beads
   5. volumetric flasks (500 ml and 1 liter
   6. Erlenmeyer flask (500 ml)
   7. graduated cylinders (100 ml and 500 ml)
c. Describe routine procedures for recording data.
d. Describe safety procedures.
e. Describe the calculations [in TKN (mg/l)] for Kjeldahl nitrogen.
f. Determine the Kjeldahl nitrogen for each sample.

OBJ 7: Report and interpret the Kjeldahl nitrogen results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. Results will be interpreted by:

a. Calculating the TKN.
b. Comparing the value with results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and

take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4), charts, nomographs, standard curves, and laboratory notebooks.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Hydrolysis of glycine, urea, glutamic acid, cyanates and acetamide
b. Ketone
c. Aldehydes
d. Alcohols
e. Amines
f. Chlorine

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Kjeldahl digestion apparatus						x		
Ion exchange column						x		
pH meter						x		
Spectrophotometer						x		
Kjeldahl flask (800 ml)						x		
Condenser						x		
Condenser adapter						x		
Glass beads						x		
Volumetric flasks (500 ml and 1 liter)						x		
Erlenmeyer flask (500 ml)						x		
Graduated cylinders (100 ml and 500 ml)						x		
Sample bottles	x	x	x	x				
Ammonia-free water						x		
Mercuric oxide (H_gO)						x		
Sulfuric acid (H_2SO_4)						x		
Potassium sulfate (K_2SO_4)						x		

EQUIPMENT AND SUPPLIES (Continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Sodium hydroxide (NaOH)						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		
Phenolphthalein						x		
Ethyl alcohol						x		
Methyl red						x		
Methylene blue						x		
Boric acid (H_3BO_3)						x		
Sodium carbonate (Na_2CO_3)						x		
Ammonium chloride (NH_4Cl)						x		
Mercuric iodide (H_gI_2)						x		
Potassium iodide (KI)						x		

Nitrogen (Ammonia)

ENV SCI 102(12):1-8(69-71)

PURPOSE

This guide will assist you in determining all the nitrogen that exists as the ammonium ion or in the equilibrium equation:

$$NH_4^+ \rightleftharpoons NH_3 + H^+$$

The method, because of the high pH at which it is performed, shifts the equilibrium of the above equation to the right, and the NH_3 is collected in the boric acid absorbing solution. The method is suitable for domestic and industrial wastes, and for drinking, surface, and saline waters.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 102(57) and Env Sci 101:1,2(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for ammonia-nitrogen samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 100% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate ammonia nitrogen sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Selection must include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting an ammonia-nitrogen sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 100% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter

f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting an ammonia-nitrogen sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing an ammonia-nitrogen sample.

COND: Given resources (IRIS 4) and the appropriate time interval over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform an ammonia-nitrogen analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List this equipment:
    1. pH meter
    2. spectrophotometer
    3. ion exchange column
b. List these analytical supplies:
    1. Kjeldahl flask (800 ml)
    2. glass beads
    3. condenser
    4. condenser adapter
    5. graduated cylinders (100 ml and 500 ml)
    6. Erlenmeyer flask (500 ml)
    7. Volumetric flasks (500 ml and 1 liter)
c. Describe routine procedures for recording data.
d. Describe safety procedures.
e. Describe the calculations (in mg/l NH_3-N) for ammonia-nitrogen.
f. Determine the ammonia-nitrogen for each sample.

OBJ 7: Report and interpret the ammonia-nitrogen results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. Results will be interpreted by:

a. Calculating the ammonia-nitrogen.
b. Comparing the value with results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses, and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4), charts, nomographs, standard curves, and laboratory notebooks.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Aromatic amines
b. Aliphatic amines
c. Cyanate
d. Ketones
e. Aldehydes
f. Alcohols

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Ion exchange column						x		
pH meter						x		
Spectrophotometer						x		
Kjeldahl flask (800 ml)						x		
Condenser						x		
Condenser adapter						x		
Glass beads						x		
Volumetric flasks (500 ml and 1 liter)						x		
Erlenmeyer flask (500 ml)						x		
Graduated cylinders (100 ml and 500 ml)						x		
Sample bottles	x	x	x	x				
Ammonia-free water						x		
Ammonium chloride						x		
Boric acid (H_3BO_3)						x		
Methyl red						x		
Ethyl alcohol						x		
Methylene blue						x		
Mercuric iodide (H_8I_2)						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Potassium iodide (KI)						x		
Sodium hydroxide (NaOH)						x		
Sodium tetraborate ($Na_2B_4O_7$)						x		
Sulfuric acid (H_2SO_4)						x		
Sodium carbonate (Na_2CO_3)						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		

Nitrogen (Nitrate)

ENV SCI 102(13):1-8(69-71)

PURPOSE

This guide will assist you in performing the nitrate test, which is performed for three reasons:

1. it determines the progressive destruction of organic nitrogen and ammonia as they form nitrate in aerobic processes;
2. it tells whether the nitrate level of a water exceeds the 10 mg/l limit set by the U.S. Public Health Service to help prevent the disease methemoglobinemia;
3. it can provide, when combined with other data, a measure of the degree of eutrophication of a water.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37); and Env Sci 101:1i(49).

RESOURCES

IRIS: 4, 480
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for nitrate samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate nitrate sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit of stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a nitrate sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the sample taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day

d. Frequency (retention time considered)
e. Collection of a representative sample
f. Absence of floating matter
g. Labeling of container to show date, place, time, and name of person who collected sample
h. Preservative

OBJ 4: Describe and demonstrate the procedure for transporting a nitrate sample to the laboratory.

COND: Given resources (IRIS 4) and an interval of up to 24 hours from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a nitrate sample.

COND: Given resources (IRIS 4) and an interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a nitrate analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the following reagents and explain their roles in the analysis:
   1. anhydrous potassium nitrate
   2. sodium arsenite
   3. brucine sulfate
   4. sulfuric acid
   5. sulfanilic acid
   6. sodium chloride
b. List this equipment:
   1. spectronic 20
   2. pH meter
   3. balance
   4. water bath
c. List these analytical supplies:
   1. bottles
   2. volumetric flasks
   3. spectrophotometer tubes
   4. test tubes
   5. pipet
   6. beaker
d. Describe routine procedure for recording data.
e. Describe the calculations (in mg/l) for nitrate.
f. Prepare and standardize the necessary reagents.
g. Describe safety procedures.
h. Determine the nitrate content of each sample.

OBJ 7: Report and interpret the nitrate results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results will be interpreted by:

a. Obtaining a standard curve by plotting the absorbance of standards (minus the absorbance of their corresponding "blanks" without brucine sulfate) against mg NO_3 - N/l.

b. Subtracting the absorbance of the "blank" sample from the absorbance of the sample, and using this value and the standard curve to determine the concentration of NO_3 - N.
c. Comparing the nitrate concentration with results of other groups performing the same analysis.
d. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Strong oxidants
b. Strong reductants
c. Residual chlorine
d. Iron
e. Nitrate
f. Chloride
g. High concentrations of organic matter

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Spectrophotometer (410 mm)						x		
1 liter volumetric flask						x		
200 ml volumetric flask						x		
100 ml volumetric flask						x		
10 ml volumetric flask						x		
30 ml test tubes (12)						x		
Test tube rack						x		
Spectrophotometer tubes						x		
Analytical balance						x		
10 ml pipet						x		
pH meter						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Cold water bath (0-10°C)						x		
Hot water bath (100°C)						x		
Graph paper							x	x
Sample carrier				x				
Anhydrous potassium nitrate (KNO_3)						x		
Sodium arsenite (NaA_5O_2)						x		
Brucine sulfate						x		
Hydrochloric acid (conc. HCl)						x		
Sulfanilic acid						x		
Sulfuric acid (conc. H_2SO_4)						x		
Sodium chloride (NaCl)						x		

Nitrogen (Nitrite)

ENV SCI 102(14):1-8(69-71)

PURPOSE

This guide will assist you in determining the nitrite content of any water or wastewater. The nitrite test, like the nitrate test, helps determine the progressive destruction of organic nitrogen and ammonia as they react to form nitrate by the aerobic processes indicated below:

$$O_2 + N_2 + NH_3 \longrightarrow NO_2 + NO_3$$

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37); and Env Sci 101:1i(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of water and Wastes" (IRIS number not yet assigned)

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for nitrite samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate nitrite samples location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Selection must include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a nitrite sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the sample taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a nitrite sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a nitrite sample.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a nitrite analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the following reagents and explain their roles in the analsis:
   1. hydrochloric acid
   2. sulfanilamide
   3. N-(naphthyl) ethylenediamine dihydrochloride
   4. sodium nitrite
   5. sodium acetate
   6. chloroform
b. List this equipment:
   1. spectronic 20
   2. balance
   3. pH meter
c. List these analytical supplies:
   1. bottles
   2. volumetric flasks
   3. spectrophotometer tubes
   4. pipets
d. Describe routine procedures for recording data.
e. Describe the calculations (in mg/l) for nitrate.
f. Prepare and standardize the necessary reagents.
g. Describe safety procedures.
h. Determine the nitrite content of each sample.

OBJ 7: Report and interpret the nitrite results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results will be interpreted by:

a. Obtaining standard curve by plotting the absorbance of the standards (minus blank) against mg NO_2 - N/1.
b. Reading the concentration of the unknown sample by using its value of absorbance (minus blank) and the curve.
c. Comparing the nitrite concentration with results of other groups performing the same analysis.
d. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interference resulting from:

a. Strong oxidants
b. Strong reductants
c. High alkalinity

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Spectrophotometer (540 mm)						x		
1 liter volumetric flask						x		
250 ml volumetric flask						x		
50 ml volumetric flask						x		
Spectrophotometer tubes						x		
10 ml pipet						x		
Analytical balance						x		
pH meter						x		
Graph paper							x	
Sample carrier				x				
Hydrochloric acid (conc. Hcl)						x		
Sulfanilamide						x		
N - (1-naphthyl) ethylenediamine dihydrochloride						x		
Sodium nitrite (anhydrous) ($NaNO_3$)						x		
Sodium acetate ($NaC_2H_2O_2$)						x		
Chloroform							x	

Total Phosphorus (Orthophosphates)

ENV SCI 102(17, 15):1-8(69-71)

PURPOSE

This guide will assist you in determining the total phosphorous content of any water or wastewater. This total phosphorous test:

1. measures the concentration of orthophosphates;
2. measures the concentration of polyphosphates;
3. measures the concentration of organic phosphcrous.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37) and Env Sci 101:1h, i (49).

RESOURCES:

IRIS: 4, 480, 542
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned)

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for inorganic phosphorous samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident. Must take appropriate action to assure that all phosphorous absorbed on the glassware is removed.

OBJ 2: Select appropriate inorganic phosphorous sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a phosphorous sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)

e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample
h. Preservation

OBJ 4: Describe and demonstrate the procedure for transporting a phosphorous sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a phosphorous sample.

COND: Given resources (IRIS 4) and an interval (up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a phosphorous analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation. Safety procedures must be followed 100% of the time. Include:

a. Prepare or obtain a list of chemicals, equipment, and analytical supplies needed to perform a persulfate digestion, followed by an ascorbic acid colorimetric determination.
b. List the reagents and explain their roles in the analysis.
c. Prepare and standardize the reagents.
d. Describe safety procedures.
e. Perform the phosphorous analysis.
f. Record data and calculate the phosphorous content.

OBJ 7: Report and interpret the inorganic phosphorous results, using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. Results will be interpreted by:

a. Obtaining a standard curve by plotting the absorbance of the standards against (mg P/l).
b. Reading the concentration of the unknown sample by using its value of absorbance and the standard curve.
c. Comparing the phosphorous concentration with results of other groups performing the same analysis.
d. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses, and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Arsenate
b. Fluoride
c. Thorium
d. Bismuth
e. Sulfide
f. Thiosulfate
g. Thiocyanate
h. Molybdate
i. Ferrous

Must also outline procedure to find:

a. Polyphosphate
b. Organic phosphorous
c. Orthophosphate without digestion

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Drying oven						x		
1000 ml volumetric flask	x					x		
100 ml volumetric flask	x					x		
10 ml graduated cylinder	x					x		
100 ml graduated cylinder	x					x		
Hot plate						x		
250 ml Erlenmeyer flask	x					x		
Spectrophotometer (Baush-Lomb) (20 or 70)		x				x		
500 ml volumetric flask	x					x		
250 ml dark glass bottles (2)	x					x		
500 ml dark plastic bottles (2)	x					x		
Refrigerator (4°C)					x			
20 ml volumetric pipet	x					x		
125 ml Erlenmeyer flask	x					x		
Graph paper						x	x	
Straightedge						x	x	
Sample carrier				x				

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Phenolphthalein indicator solution						x		
Sulfuric acid (conc. H_2SO_4)						x		
Ammonium persulfate $[(NH_4)_2S_2O_8]$						x		
Sodium hydroxide (NaOH)						x		
Ethyl alcohol (95%)						x		
Antimony potassium tartrate $[K(SbO)C_4H_4O_6 \cdot \frac{1}{2}H_2O]$						x		
Ammonium molybdate $[(NH_4)_6Mo_7O_{24}4H_2O]$						x		
Ascorbic acid						x		
Potassium dihydrogen phosphate (KH_2PO_4)						x		
Hydrochloric acid (HCl)	x							

Total Organic Carbon

ENV SCI 102(16):1-8(69-71)

PURPOSE

This guide will assist you in learning how to perform the analysis for total organic carbon. This test is used to analyze for all forms of organic carbon without discrimination, so any pretreatment may affect the results and should be clearly stated. The presence of carbonate and bicarbonate will appear as total organic carbon unless removed or subtracted after analysis.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 102(57) and Env Sci 101:1,2(49).

RESOURCES

IRIS: 4, 771
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned)

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for the total organic carbon analysis.

COND: Given one of the resources and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in one of the above resources, with great care to prevent all organic contamination, such as detergents.

OBJ 2: Describe and demonstrate the procedure for collecting a sample for the total organic carbon analysis.

COND: Given one of the resources, a location, and the nature of the sample.

PL: 90% of the samples taken must be taken in conformance with procedures in one of the above resources, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequence
e. Preservation

OBJ 3: Describe and demonstrate the procedure for transporting a sample to the laboratory for total organic carbon analysis.

COND: Given one of the resources and a 24-hour time limit for transportation.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in one of the above resources, especially with no organic contamination.

OBJ 4: Describe and demonstrate the procedure for storing samples in the laboratory for total organic carbon analysis.

COND: Given one of the resources and the storage time required, up to 24 hours.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 5: Select appropriate sample location in plant or on watercourse for total organic carbon analysis.

COND: Given one of the following resources:

a. Plant operational guide for plant in question.
b. One of the listed resources above.

Given the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting a regulatory requirement.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or on stream
c. Depth

OBJ 6: Describe and perform the analysis for the total organic carbon analysis, including proper safety procedure.

COND: Given one of the listed resources and an equipped laboratory.

PL: 90% of samples must fall within acceptable range as defined in one of the resources. Safety procedures must be followed 100% of the time.

OBJ 7: Describe and perform the procedure for the total organic carbon analysis, including reporting and interpreting the results.

COND: Given one of the resources, standard curves, and the data.

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources.

OBJ 8: Recognize an abnormal condition in the total organic carbon analysis in any performance in objectives 1-7, and suggest and take the action necessary to correct the abnormal condition.

COND: Given one of the following resources:

a. Laboratory control guide for plant in question.
b. One of the resources above.

Given charts, nomographs, standard curves, calculator, laboratory logbooks.

PL: 80% of abnormal conditions must be spotted and corrected to meet performance level in objective 1-7.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
30 ml beakers						x		
Blender						x		
Hypodermic syringe (500 ml)						x		
Magnetic stirrer						x		
Packing for oxidation tube of total organic carbon analyzer						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Redistilled water						x		
Sample bottles	x	x	x	x		x		
Total organic carbon analyzer						x		
1 liter volumetric flasks						x		
Standard carbon solution containing sodium oxalate						x		
Hydrochloric acid						x		
Nitrogen gas - CO_2 free						x		
Oxygen gas - CO_2 free						x		

Alkalinity, Acidity, and pH

ENV SCI 102(19,18,9):1-8(69-71)

PURPOSE

This guide will assist you in determining the acidity and alkalinity of a water sample. The alkalinity of a water sample is a measure of its capacity to neutralize acids. The three major ions which contribute to the alkalinity of water are: 1. hydroxide, 2. carbonate, and 3. bicarbonate. These ions, usually provided by salts of weak acids or strong bases, act to prevent a drop in pH even when acid is being added. The equations below show how each of these ions neutralizes the H^+, which is the acid character of solutions.

1. $OH^- + H^+ \longrightarrow HOH$
2. $CO_3^= + H^+ \longrightarrow HCO_3^-$
3. $HCO_3^- + H^+ \longrightarrow H_2CO_3$

In this guide you will measure this buffering action (alkalinity) in a water sample.

The acidity of a water sample is a measure of its capacity to neutralize bases. The two main types of acidity are: 1. carbon dioxide acidity, and 2. mineral acidity. The equations below show how CO_2, S, FeS_2, and $FeCl_3$ act to produce acidity.

1. $CO_2 + H_2O \rightleftharpoons H_2CO_3$

   $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

   $HCO_3^- \rightleftharpoons H^+ + CO_3^=$

2. $2S + 3O_2 + 2H_2O \rightleftharpoons 2H_2SO_4$

   $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^=$

3. $2FeS_2 + 7O_2 + 2H_2O \rightleftharpoons FeSO_4 + H_2SO_4$

   $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^=$

4. $FeCl_3 + 3H_2O \rightleftharpoons Fe(OH)_3 + 3H^+ + 3Cl$

In this guide you will measure the acidity of a water sample.

As noted on the preceding page, there are three main types of alkalinity and two types of acidity. The pH of the water sample determines which type will be present. The chemistry of the reactions governed by this pH is beyond the scope of this guide, but is covered in Chem 102(57).

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37); and Env Sci 101:1h (49).

RESOURCES

IRIS: 4, 413, 466, 1027
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned)

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for alkalinity and acidity samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4.

OBJ 2: Select appropriate alkalinity and acidity sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting an alkalinity and acidity sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of container to show date, place, time, and name of person who collected sample
h. Preservation

OBJ 4: Describe and demonstrate the procedure for transporting an alkalinity and acidity sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis

in conformance with procedures described in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing an alkalinity and acidity sample.

COND: Given resources (IRIS 4) and the time interval over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed time.

OBJ 6: Describe and perform an alkalinity and acidity analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of time.

Include:

a. List the following reagents and explain their roles in the analysis:
    1. sodium hydroxide
    2. potassium biphthalate
    3. hydrochloric acid
    4. sulfuric acid
    5. sodium thiosulfate
    6. sodium carbonate
b. List this equipment:
    1. hot plate
    2. balance
    3. pH meter
c. List these analytical supplies:
    1. buret
    2. beaker
    3. flasks
    4. volumetric flasks
    5. dropper
d. Describe routine procedures for recording data.
e. Describe the calculations in (mg/l $CaCO_3$) for acidity and alkalinity.
f. Prepare and standardize the necessary reagents.
g. Describe safety procedures.
h. Determine the acidity and alkalinity for each sample.

OBJ 7: Report and interpret the alkalinity and acidity results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. The results will be interpreted by:

a. Comparing the acidity and alkalinity with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Iron sulfate
b. Aluminum sulfate
c. Residual chlorine
d. Calcium carbonate
e. Magnesium hydroxide
f. Salts of weak inorganic and organic acids

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
50 ml buret						x		
Hot plate						x		
250 ml beaker						x		
250 ml Erlenmeyer flask						x		
Analytical balance that weighs to 0.001 grams						x		
1 liter volumetric flask						x		
100 ml graduated cylinder						x		
Sample carrier				x				
Thermometer						x		
pH meter						x		
Concentrated sulfuric acid (H_2SO_4)						x		
Anhydrous (primary standard grade) sodium hydroxide (Na_2CO_3)						x		
Sodium hydroxide (NaOH)						x		
Hydrogen peroxide (H_2O_2) (30% solution)						x		

Hardness

ENV SCI 102(20):1-8(69-71)

PURPOSE

This guide will assist you in determining the hardness of a water sample. Hard waters are those water supplies which produce scale ($CaCO_3$) when heated, and also require large amounts of soaps and detergents to produce clean clothes.

The scale found in hot water heaters, pipes, and boilers (even in tea kettles) is due to the high temperature precipitation of calcium carbonate from calcium bicarbonate according to the equation:

$$Ca(HCO_3)_2 \longrightarrow CaCO_3\downarrow + H_2O + CO_2\uparrow$$

The cost of chemicals to prevent such precipitation is usually high, and thus the sanitary engineer seeks to avoid hard water supplies.

Calcium and magnesium ions in water are causative agents of the soap curds that are often found in clothes washers in hard water areas. The formation of these curds, produced as Ca^{+2} and Mg^{+2} ions combined with the soap molecule, is represented as follows:

$$2C_{17}H_{35}COONa + Ca(HCO_3)_2 \longrightarrow$$

$$(C_{17}H_{35}COO)_2Ca\downarrow + 2NaHCO_3$$

The equation indicates that the soap preferentially attracts the Ca^{+2} ion, rather than the dirt particles it was meant to attract.

Hard water, therefore, needs an extra amount of soap to satisfy the ion requirement before the dirt requirement can be met.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47j(37).

RESOURCES

IRIS: 4, 1363, 2575
"Methods for Chemical Analysis of water and Wastes" (IRIS number not yet assigned)

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for hardness samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate hardness sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), drinking water treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:
- a. Location in plant
- b. Location in process unit or stream
- c. Depth
- d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedure for collecting a hardness sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:
- a. Depth
- b. Sampling equipment needed
- c. Time of day
- d. Frequency (retention time considered)
- e. Absence of floating matter
- f. Collection of a representative sample
- g. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a hardness sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:
- a. Control of temperature
- b. Exclusion of light
- c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a hardness sample.

COND: Given resources (IRIS 4) and the time interval (up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a hardness analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation. Safety procedures must be followed 100% of the time.

Include:
- a. Prepare or obtain a list of reagents, equipment, and analytical supplies needed to perform the hardness tests.
- b. Describe the end points in the titrations.
- c. Describe the routine procedures for recording data.
- d. Describe the calculations (in mg/l $CaCO_3$) for total and CA^{+2} hardness.
- e. Prepare and standardize the necessary reagents.
- f. Describe safety procedures.
- g. Determine the hardness of each sample.

OBJ 7: Report and interpret the hardness results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretations must conform to

those in resources. The results will be interpreted by:

a. Calculating the Ca^{++}, Mg^{++}, and Total Hardness.
b. Comparing the hardness values with results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given laboratory control guide for plant in question, typical hardness curves and data, laboratory logbooks, and a calculator.

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Strontium
b. Silica
c. Aluminum
d. Iron
e. Manganese
f. Phosphate
g. Suspended matter

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
50 ml buret						x		
250 ml Erlenmeyer flask						x		
50 ml graduated cylinder						x		
10 ml graduated cylinder						x		
Eyedropper						x		
pH meter						x		
Sample carrier				x				
500 ml bottles (2)				x				
100 ml volumetric flask						x		
1 liter volumetric flask						x		
Magnesium salt of EDTA						x		
Eriochrome Black T						x		
Sodium chloride (NaCl)						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Disodium salt of EDTA						x		
Hydrochloric acid (HCl)						x		
Ammonium chloride (NH_4Cl)						x		
Ammonium hydroxide (NH_4OH)						x		
Calcium carbonate ($CaCO_3$ anhydrous) (primary standard)						x		
Sodium hydroxide (NaOH)						x		
Murexide						x		

Volatile Acids (Total Organic Acids)

ENV SCI 102(21,22):1-8(69-71)

PURPOSE

This guide will assist you in determining the volatile acid content of a sample by use of the total organic acid method. The determination of volatile acids in sludge provides valuable information on the efficiency of sludge digestion. In normal anaerobic digestor operation, the organic materials in the sludge are first converted to low molecular weight compounds (chiefly volatile acids, of which 70% is usually acetic acid), and then these compounds are converted to methane and carbon dioxide by methane-forming bacteria. When the digestor operates efficiently, the bacteria form methane and the volatile acid content of digesting sludge remains in the range of 50-250 mg/l (expressed as acetic acid). At pH values below 6.5, the methane bacteria are seriously inhibited, and the volatile acid concentration increases to levels of 250 mg/l or higher. These high levels indicate that the organic solids are no longer being efficiently converted to methane and carbon dioxide, and that corrective action must be taken to restore the digestor to proper operation.

PREREQUISITES

Before beginning this module, you should have successfully completed Chem 101: 46e,f(36) and 47j(37).

RESOURCES

IRIS: 4, 142

OBJECTIVES

OBJ 1: Describe and demonstrate the procedures for the preparation of containers for volatile acids samples.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water or stains will be evident.

OBJ 2: Select appropriate volatile acids sample location in a wastewater plant.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a volatile acid sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and plant operational manual.

PL: 90% of the samples taken must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency
e. Collection of a representative sample
f. Labeling of container to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a volatile acid sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (usually within 6 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a volatile acid sample.

COND: Given resources (IRIS 4) and the time interval (usually within 6 hours) over which the sample is to be stored in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a volatile acid analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation. Safety procedures must be followed 100% of the time.

Include:

a. List the following reagents and explain their roles in the analysis:
   1. silicic acid
   2. chloroform
   3. n-butanol
   4. sulfuric acid
   5. thymol blue
   6. methanol
   7. phenolphthalein
   8. sodium hydroxide
b. List this equipment:
   1. gravity filter
   2. desiccator
   3. gas (CO_2) supply
c. List these analytical supplies:
   1. beakers
   2. separatory funnel
   3. filter paper
   4. funnel
   5. pipet
   6. gooch crucible
   7. filtering flask
   8. buret
d. Describe routine procedures for recording data.
e. Describe the calculations (in mg/l) for volatile acids.
f. Prepare and standardize the necessary reagents.
g. Describe safety procedures.
h. Determine the volatile acid content of each sample.

OBJ 7: Report and interpret the volatile acids results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretations must conform to those in resources. The results will be interpreted by:

a. Comparing results with those of other groups performing the same analysis.
b. Showing any disagreement.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:
a. High volatile acid concentration (5000 mg/1).
b. Presence of other organic acids.
c. Appearance of a white precipitate.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
100 ml glass or plastic bottle		x						
Centrifuge/vacuum filtering assembly						x		
Gooch crucible						x		
GFC filter paper						x		
1000 ml beaker						x		
Oven 103^{o}C						x		
Separatory funnel (500 ml)						x		
Gravity filter						x		
Filter paper						x		
Eyedropper						x		
5 ml pipet						x		
He gas tank						x		
50 ml buret						x		
Sample carrier				x				
Silicic acid						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Chloroform						x		
n - butanol						x		
Sulfuric acid (H_2SO_4)						x		
Thymol blue indicator						x		
Methanol (absolute)						x		
Phenophthalein						x		
Sodium hydroxide (NaOH)						x		

Functions of Wastewater Treatment Processes

ENV SCI 103:1(73)

PURPOSE

This guide will assist you in determining the function of a wastewater treatment process. In order for a technician to select sampling location, types of samples, and frequency of sampling, he must be able to describe the purpose of a unit process and how it affects the wastestream.

PREREQUISITES

None

RESOURCES

IRIS: 1505, 1506

OBJECTIVES

OBJ 1: Define the terms used to describe the characteristics of wastewater.

COND: Given a list of wastewater characteristics, including:

- Wastewater
- Domestic wastewater
- Industrial wastewater
- Storm water
- Combined wastewater
- Scum
- Skimmings
- Settleable solids
- Grit
- Sludge
- Colloids
- Flow
- Alkalinity
- BOD_5
- COD
- Total solids
- Total dissolved solids
- Total suspended solids
- Total volatile solids
- Ammonia
- Kjeldahl nitrogen
- Nitrate
- Nitrite
- Total phosphorus
- Acidity
- Total organic carbon
- Hardness
- Metals
- Organic nitrogen
- Orthophosphate
- Sulfate
- Sulfide
- Sulfite
- Bromide
- Chlorine
- Cyanide
- Fluoride
- Chloride
- Oil and grease
- Phenols
- Surfactants
- Algicides
- Benzidine
- Chlorinated organic compounds
- Pesticides
- Color
- Specific conductance
- Turbidity
- Alpha, total
- Beta, total
- Radium
- Fecal streptoccoci
- Fecal coliform
- Total coliform
- Temperature
- Dissolved oxygen
- Aerobic

Anaerobic
Septic
Nutrients
Bacteria
Strong wastewater
Average wastewater
Weak wastewater
Microorganisms
Pathogenic bacteria
Pathogens
Organic
Inorganic
Toxic

(Plus all other items in Appendix II, pages 256-257 of curriculum.)

PL: 80%

OBJ 2: Describe the process unit(s) used to perform each of the major wastewater treatment processes.

COND: Given photographs of the following process units:

a. Collection-combined system with industrial wastes
b. Chlorination-vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator
c. Screening and grinding-mechanically cleaned bubbler controlled unit with grinder
d. Grit removal-aerated unit with bucket elevator
e. Primary sedimentation-rectangular unit with telescopic valve draw off, density meter time clock, and trough with scraper
f. Trickling filtration-rotary distributor, standard rate unit with dosing tank
g. Activated sludge aeration-diffused air unit with swing type diffuser producing fine bubbles
h. Secondary sedimentation-circular, peripheral feed unit with suction sweeps
i. Pond stabilization-aerobic pond
j. Thickening-flotation unit with air
k. Anaerobic digestion-fixed cover, gas recirculation unit with external heat exchanger
l. Sludge conditioning-chemical conditioning unit with counter-current elutriation
m. Sludge dewatering-vacuum filter with cloth and continuous feed centrifuge
n. Solids disposal-multiple hearth incineration unit
o. Effluent disposal-direct reuse system
p. Flow measurement and instrumentation-centralized recording and totalizing system, including Parshall flume, Venturi meter, magnetic flow meter, and rotameter
q. Pumping and piping-variable speed type pumping station with bubbler tube control system, and separate drywell and wetwell
r. Electrical power-electrical switch gear, automatic circuit actuators on motors, telemetering with alarms, and emergency generators
s. Gas power-system with gas produced in anaerobic digestion process with high pressure storage tanks using rotary positive displacement compressors
t. Chemical treatment
u. Sand filtration
v. Activated carbon
w. Reverse osmosis
x. Electrodialysis
y. Ozonation
z. Hyperfiltration
aa. Ion exchange
bb. Distillation

PL: Include:
- a. Name of process unit
- b. Type of process
- c. Technical classes of materials removed or treated by the process unit
- d. Examples of materials removed or treated by the process unit
- e. Nontechnical functional description of the process unit

OBJ 3: Name the process units and describe the physical, chemical, and biological principles involved in their functioning that bring about a change in a characteristic of a wastestream.

COND: Given one or more of the following characteristics:
- a. Scum
- b. Skimmings
- c. Settleable solids
- d. Grit
- e. Temperature
- f. Dissolved oxygen
- g. Microorganisms
- h. Pathogenic bacteria

(Plus all items in Appendix II, pages 256-257 of curriculum.)

PL: Include a listing of the technical classes of materials treated or removed by each process unit and a technical description of how the process unit affects each of these classes of materials.

EQUIPMENT AND SUPPLIES

None

Selection of Process Control and Regulatory Tests

ENV SCI 103:2(73)

PURPOSE

This guide will assist you in learning how to select proper testing procedures to meet process control or regulatory requirements.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 103: 1(73).

RESOURCES

IRIS; 1505, 1506

OBJECTIVES

OBJ 1: List the values or ranges of wastewater characteristics expected in raw wastewater.

COND: Given list of characteristics and list of values for each:

a. Scum
b. Skimmings
c. Settleable solids
d. Grit
e. Temperature
f. Dissolved oxygen
g. Microorganisms
h. Pathogenic bacteria

(Plus all items in Appendix II, pages 256-257 of curriculum.)

PL: Include values, ranges, and weak, average, or strong.

OBJ 2: Select from a list of tests those that will evaluate whether a process unit meets requirements.

COND: Given:

a. List of characteristics:
    1. scum
    2. skimmings
    3. settleable solids
    4. grit
    5. temperature
    6. dissolved oxygen
    7. microorganisms
    8. pathogenic bacteria

(Plus items in Appendix II, pages 256-257.)

b. NPDES permit.
c. State regulatory requirements.
d. Process control requirements.
e. List of unit processes:
    1. collection-combined system with industrial wastes
    2. chlorination-vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator
    3. screening and grinding-mechanically cleaned bubbler controlled unit with grinder
    4. grit removal-aerated unit with bucket elevator
    5. primary sedimentation-rectangular unit with telescopic valve draw off, density meter time clock, and trough with scraper
    6. trickling filtration-rotary distributor, standard rate unit with dosing tank

7. activated sludge aeration-diffused air unit with swing type diffuser producing fine bubbles
8. secondary sedimentation-circular, peripheral feed unit with suction sweeps
9. pond stabilization-aerabic pond
10. thickening-flotation unit with air
11. anaerobic digestion-fixed cover, gas recirculation unit with external heat exchanger
12. sludge conditioning-chemical conditioning unit with counter-current elutriation
13. sludge dewatering-vacuum filter with cloth and continuous feed centrifuge
14. solids disposal-multiple hearth incineration unit
15. effluent disposal-direct reuse system
16. flow measurement and instrumentation-centralized recording and totalizing system, including Parshall flume, Venturi meter, magnetic flow meter, and rotameter
17. pumping and piping-variable speed type pumping station with bubbler tube control system, and separate drywell and wetwell
18. electrical power-electrical switch gear, automatic circuit actuators on motors, telemetering with alarms and emergency generators
19. gas power-system with gas produced in anaerobic digestion process with high pressure storage tanks using rotary positive displacement compressors
20. chemical treatment
21. sand filtration
22. activated carbon
23. reverse osmosis
24. electrodialysis
25. ozonation
26. hyperfiltration
27. ion exchange
28. distillation

PL: Include:
- a. Correct test for each regulation.
- b. Acceptable range or value for each parameter.
- c. 90% correct.

EQUIPMENT AND SUPPLIES

None

Effect of Pollutants

ENV SCI 103:3(73)

PURPOSE

This guide will assist you in determining the effect of pollutants on a water or wastewater. To evaluate the need and purpose of changing a wastewater characteristic, a technician needs to determine the effect on the treatment process or receiving stream.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 103: 2(73).

RESOURCES

IRIS: 1505, 1506

OBJECTIVES

OBJ 1: Describe the effect that given wastewater characteristic(s) will have on a treatment process or receiving stream.

COND: Given:

a. List of characteristics, including:
   1. scum
   2. skimmings
   3. settleable solids
   4. grit
   5. temperature
   6. dissolved oxygen
   7. pathogenic bacteria

b. List of unit processes, including:
   1. collection-combined system with industrial wastes
   2. chlorination-vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator
   3. screening and grinding-mechanically cleaned bubbler controlled unit with grinder
   4. grit removal-aerated unit with bucket elevator
   5. primary sedimentation-rectangular unit with telescopic valve draw off, density meter time clock, and trough with scraper
   6. trickling filtration-rotary distributor, standard rate unit with dosing tank
   7. activated sludge aeration-diffused air unit with swing type diffuser producing fine bubbles
   8. secondary sedimentation-circular, peripheral feed unit with suction sweeps
   9. pond stabilization-aerobic pond
   10. thickening-flotation unit with air
   11. anaerobic digestion-fixed cover, gas recirculation unit with external heat exchanger
   12. sludge conditioning-chemical conditioning unit with counter-current elutriation
   13. sludge dewatering-vacuum filter with cloth and continuous feed centrifuge
   14. solids disposal-multiple hearth incineration unit
   15. effluent disposal-direct reuse system

16. flow measurements and instrumentation-centralized recording and totalizing system, including Parshall flume, Venturi meter, magnetic flow meter, and rotameter
17. pumping and piping-variable speed type pumping station with bubbler tube control system, and separate drywell and wetwell
18. electrical power-electrical switch gear, automatic circuit actuators on motors, telemetering with alarms, and emergency generators
19. gas power-system with gas produced in anaerobic digestion process with high pressure storage tanks using rotary positive displacement compressors
20. chemical treatment
21. sand filtration
22. activated carbon
23. reverse osmosis
24. electrodialysis
25. ozonation
26. hyperfiltration
27. ion exchange
28. distillation

PL: Include 80% of the physical, chemical or biological effects upon the treatment process or receiving stream.

EQUIPMENT AND SUPPLIES

None

Flow Diagrams

ENV SCI 103:4(73-74)

PURPOSE

This guide will assist you in learning to use flow diagrams to illustrate treatment systems.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 103: 3(73).

RESOURCES

IRIS: 1505, 1506

OBJECTIVES

OBJ 1: Construct flow diagrams containing the most probable process unit(s) needed to accomplish given treatment requirements.

COND: Given:

a. List of characteristics, including:
   1. temperature
   2. dissolved oxygen
   3. microorganisms
   4. pathogenic bacteria
   5. scum
   6. skimmings
   7. settleable solids
   8. grit

(Plus all items in Appendix II, pages 256-257 of curriculum.)

b. NPDES permit.

c. State regulatory requirements.

d. Process control requirements.

e. List of unit processes, including:
   1. collection-combined system with industrial wastes
   2. chlorination-vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator
   3. screening and grinding-mechanically cleaned bubbler controlled unit with grinder
   4. grit removal-aerated unit with bucket elevator
   5. primary sedimentation-rectangular unit with telescopic valve draw off, density meter time clock, and trough with scraper.
   6. trickling filtration-rotary distributor, standard rate unit with dosing tank
   7. activated sludge aeration-diffused air unit with swing type diffuser producing fine bubbles
   8. secondary sedimentation-circular, peripheral feed unit with suction sweeps
   9. pond stablization-aerobic pond
   10. thickening-flotation unit with air
   11. anaerobic digestion-fixed cover, gas recirculation unit with external heat exchanger
   12. sludge conditioning-chemical conditioning unit with counter-current elutriation

13. sludge dewatering-vacuum filter with cloth, and continuous feed centrifuge
14. solids disposal-multiple hearth incineration unit
15. effluent disposal-direct reuse system
16. flow measurement and instrumentation-centralized recording and totalizing system, including Parshall flume, Venturi meter, magnetic flow meter, and rotameter
17. pumping and piping-variable speed type pumping station with bubbler tube control system, and separate drywell and wetwell
18. electrical power-electrical switch gear, automatic circuit actuators on motors, telemetering with alarms and emergency generators.
19. gas power-system with gas produced in anaerobic digestion process with high pressure storage tanks using rotary positive displacement compressors
20. chemical treatment
21. sand filtration
22. activated carbon
23. reverse osmosis
24. electrodialysis
25. ozonation
26. hyperfiltration
27. ion exchange
28. distillation

f. Performance capabilities of unit processes.

PL: Include:

a. All major unit processes (no extra unit processes may be included), such as:
   1. collection
   2. preliminary treatment
   3. primary treatment
   4. secondary treatment
   5. disinfection
   6. effluent disposal
   7. advanced wastewater treatment
   8. solids treatment and disposal

b. All flow directions and additions of chemicals.

EQUIPMENT AND SUPPLIES

None

Summer Laboratory Experience

ENV SCI 104:1,2(77)

PURPOSE

This course will give you an actual work experience in a laboratory concerned with water quality analysis. Through this hands-on experience you will be given the opportunity to develop both analytical skills and interpersonal skills to enable you to more clearly define career goals.

(The information following is from a water management summer experience course offered at Ulster County Community College, Stone Ridge, NY. Similar information about your own course is to be provided by the instructor, along with the outline of objectives, conditions, and performance levels.)

REQUIREMENTS FOR A GRADE OF D

1. Co-op in the laboratory of a water related work area for not less than 6 weeks.

2. Schedule an interview with the co-op director prior to going out to assigned work area.

3. Attend a co-op orientation session.

4. Complete a statement of learning objectives related to career/academic goals.

5. Submit a co-op workbook/laboratory notebook which reports data collected during the work experience.

6. Submit a daily log which details activity and progress toward the learning objectives.

7. Submit a term paper during the 4th week of the fall semester following the co-op experience which will include: purpose, procedure, results, calculations, conclusions, and an analysis of learning objectives achieved.

8. Attend co-op seminars as scheduled.

9. Perform all water quality tests as directed by immediate supervisor.

10. Fill out weekly and mail to the Water Management Division two copies of the Weekly Time Sheet and one copy of the Student Evaluation of Cooperative Education Experience.

11. Assure that immediate supervisor fills out the Employer's Final Evaluation Reports according to the following schedule:
    1st copy - after 2 weeks
    2nd copy - after 1 month
    3rd copy - after 2 months
    4th copy - at co-op termination

12. Return all equipment to Ulster County Community College.

REQUIREMENTS FOR A GRADE OF C

All the requirements (1-12) as stated in the grade D and in addition:

13. Perform a pH, a DO, a BOD, an acidity, a temperature, and an alkalinity determination at a selected sample site not less than once every two weeks.

REQUIREMENTS FOR A GRADE OF B

All the requirements (1-13) as stated in the grade C and in addition:

14. Complete a base-line water quality study of at least one site in a source of water, body of water, treatment

facility, or flowing stream within the work area. Such study should include, at minimum, the determination on a bi-weekly basis of 10 of the following water quality parameters:

a. DO
b. BOD
c. Acidity
d. Alkalinity
e. pH
f. Chlorine Residual
g. Fecal Coliform
h. Total Coliform
i. Temperature
j. Suspended Solids
k. Settleable Solids
l. Turbidity
m. Hardness
n. COD
o. Nitrate
p. Nitrite
q. Phosphorous
r. Ammonia

REQUIREMENTS FOR A GRADE OF A

All the requirements (1-14) as stated in the grade B and in addition:

15. The base-line water quality study performed in requirement 14 must include at least four sampling sites.

OPTION

Students working for regulatory agencies may substitute other approved work experiences for requirement 15.

Cyanide

ENV SCI 201(1):1-8(81-83)

PURPOSE

This guide will assist you in determining the cyanide content of a water or wastewater using a spectrophotometer. The cyanide test is important because the cyanide ion (CN^-) is toxic and it inhibits the microorganisms responsible for the purification of water. The method converts most cyanide forms to HCN, which is then determined by volumetric titration (CN^- > 1 mg/l) or colorimetric measurement (CN^- < 1 mg/l).

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37); and Env Sci 101:1a,e, h,i(49) and 2a,b,c,d(49).

RESOURCES

IRIS: 4, 1915
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for cyanide samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate cyanide sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a cyanide sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show

date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a cyanide sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a cyanide sample.

COND: Given resources (IRIS 4) and the time interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a cyanide analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Choose the appropriate method (CN^- concentration considered).
e. Describe routine procedures for recording data.
f. Describe safety procedures.
g. Describe the calculations (in $\underline{mg/l\ CN^-}$) for cyanide.
h. Determine the cyanide content for each sample.

OBJ 7: Report and interpret the cyanide results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the cyanide concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Sulfides
b. Fatty acids
c. Oxidizing agents

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Hot plate						x		
Allihn condenser						x		
Gas absorber						x		
Thistle tube						x		
Spectrophotometer						x		
Flasks						x		
Beakers						x		
Copper wire						x		
Volumetric flasks						x		
Graduated cylinders						x		
500 ml bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Balance						x		
Sodium hydroxide (NaOH)						x		
Cadmium carbonate ($CdCO_3$)						x		
Ascorbic acid						x		
Cuprous chloride ($CuCl_2$)						x		
Sulfuric acid (H_2SO_4)						x		
Hydrochloric acid (HCl)						x		
Sodium dihydrogen phosphate (NaH_2PO_4)						x		
Potassium cyanide (KCN)						x		
Potassium hydroxide (KOH)						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Silver nitrate ($AgNO_3$)						x		
P-dimethyl-amino-benzalrhodanine						x		
Acetone						x		
Chloramine T						x		
Barbituric acid						x		
Pyridine						x		

Color

ENV SCI 201(2): 1-8 (81-83)

PURPOSE

This guide will assist you in determining the color of nearly any sample of water. Two methods will be presented:

1. the Platinum-Cobalt method
2. the Spectrophotometric method

The Platinum-Cobalt method is used for measuring colors caused by naturally occurring materials, and the Spectrophotometric method is used for describing the color of water containing highly colored industrial wastes.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36); and Env Sci 101:1a,h,i(49) and 2a,b,c(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for color samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate color sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a color sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the sample must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show

date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a color sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a color sample.

COND: Given resources (IRIS 4) and the time interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a color analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations in number of color units for color.
g. Determine the number of color units for each sample.
h. Determine the dominant wavelength, hue, luminance, and purity for each sample.

OBJ 7: Report and interpret the color results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the color characteristics with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Comparing the color of the sample with the United States Public Health Service limits.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Turbidity
b. pH

Include a description of a procedure which could be used to determine the color response of a given water sample over a wide range of pH values.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Nessler tubes (50 ml tall form)						x		
500 ml bottles (2)	x	x	x	x	x			
Balance				x				
Sample carrier						x		
Spectrophotometer						x		
Volumetric flasks						x		
Filtering flasks						x		
Crucible						x		
Crucible holder						x		
Glass tubing						x		
Rubber tubing						x		
Three-way stopcock						x		
Potassium chloroplatinate (K_2PtCl_6)						x		
Cobaltous chloride ($CoCl_2$)						x		
Hydrochloric acid (HCl)						x		
Sodium hydroxide (NaOH)						x		
Sulfuric acid (H_2SO_4)						x		
Celite No. 505						x		

Fluoride

ENV SCI 201(3):1-8(81-83)

PURPOSE

This guide will assist you in determining the fluoride content of a water sample using the SPADNS method. The fluoride test is important because it can determine whether the fluoride level of potable water meets the recommended limit of 1.0 mg/l.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47 j(37); and Env Sci 101:1a,e, h,i(49) and 2a,b,c,d(49).

RESOURCES

IRIS: 4, 60, 1915
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for fluoride samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate fluoride sample location in a drinking water treatment plant.

COND: Given resources (IRIS 4), drinking water treatment plant operational guide, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a fluoride sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a fluoride sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from the time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a fluoride sample.

COND: Given resources (IRIS 4) and the time interval (up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a fluoride analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in mg/lf) for fluoride.
g. Determine the fluoride content for each sample.

OBJ 7: Report and interpret the fluoride results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the fluoride concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Alkalinity
b. Aluminum
c. Chloride
d. Ferric
e. Hexametaphosphate
f. Phosphate
g. Sulfate

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Spectrophotometer						x		
Hot plate						x		
Distillation apparatus						x		
Thermometer adapter						x		
Thermometer						x		
Flasks						x		
Beakers						x		
Volumetric flasks						x		
Graduated cylinders						x		
Balance						x		
SPADNS						x		
Sulfuric acid (H_2SO_4)						x		
Silver sulfate (Ag_2SO_4)						x		
Sodium fluoride (NaF)						x		
Zirconyl chloride octahydrate ($ZrOCl_2 \cdot 8\ H_2O$)						x		
Hydrochloric acid (HCl)						x		
Sodium arsenite ($NaAsO_2$)						x		

Sulfide

ENV SCI 201(4):1-8(81-83)

PURPOSE

This guide will assist you in determining the sulfide content of a water or wastewater using the Titrimetric Iodine method. The sulfide test is performed for three reasons:

1. sulfide concentrations of 0.1 mg/l can cause an objectionable odor;
2. sulfide concentrations of 200 mg/l can kill bacteria in anaerobic treatment processes;
3. corrosion of concrete sewages is often caused by H_2SO_4 formed from hydrogen sulfide:

$$\underset{\text{hydrogen sulfide}}{H_2S} + 2O_2 \xrightarrow{\text{bacteria}} \underset{\text{sulfuric acid}}{H_2SO_4}$$

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46e, f(36) and 47j(37); and Env Sci 101:1a,b, c,d,h(49) and 2a,b,d(49).

RESOURCES

IRIS: 4, 1017
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sulfide samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate sulfide sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sulfide sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample
h. Samples used for determination of total sulfide must contain a representative proportion of suspended solids

OBJ 4: Describe and demonstrate the procedure for transporting a sulfide sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing a sulfide sample.

COND: Given resources (IRIS 4) and the time interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a sulfide analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time. The student will:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Prepare and standardize the necessary reagents.
f. Describe safety procedures.
g. Describe the calculations (in mg/l S) for sulfide.
h. Determine the sulfide content for each sample.

OBJ 7: Report and interpret the sulfide results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the sulfide concentrations with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in terms of odor and toxic effects.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Sulfite
b. Thiosulfate
c. Hydrosulfite
d. Volatile iodine-consuming substances

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Nitrogen tank						x		
Nitrogen regulator						x		
Balance						x		
Hot plate						x		
1000 ml flask						x		
250 ml flasks (2)						x		
Glass tubing						x		
Rubber tubing						x		
Fritted gas-diffusion tube						x		
Graduated cylinders						x		
Buret						x		
Starch indicator						x		
Zinc acetate [$Zn(C_2H_3O_2)_2$]						x		
Nitrogen gas (N_2)						x		
Sulfuric acid (H_2SO_4)						x		
Potassium iodide (KI)						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Iodine (I_2)						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		
Hydrochloric acid (HCl)						x		
Aluminum chloride ($AlCl_3$)						x		
Sodium hydroxide (NaOH)						x		

Sulfide (H_2S,HS)

ENV SCI 201(5):1-8(81-83)

PURPOSE

This guide will assist you in determining the sulfide concentration of a water or wastewater using the Titrimetric Iodine method. The need to detect sulfide has been established for three reasons:

1. concentrations of 0.3 mg/l cause an objectionable rotten egg odor;
2. concentrations over 200 mg/l inactivate anaerobic treatment processes;
3. the oxidation of H_2S produces acids which attack concrete structures such as tanks and pipes.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47f,j(37); and Env Sci 101:1a,h(49) and 2a,b,c,d(49).

RESOURCES

IRIS: 4, 1017
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sulfide samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate sulfide sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sulfide sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS including:

a. Depth
b. Sampling equipment needed
c. Time of day

d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sulfide sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals
d. Prevention of areation of the sample

OBJ 5: Describe and demonstrate the procedure for storing a sulfide sample.

COND: Given resources (IRIS 4) and the time interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a sulfide analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in mg/l S) for sulfide.
g. Determine the sulfide content for each sample.

OBJ 7: Report and interpret the sulfide results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Calculating the sulfide concentration for each sample.
b. Comparing the result with results of other groups performing the same analysis.
c. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Sulfite
b. Thiosulfite
c. Hydrosulfite
d. Volatile iodine consuming substances

State the range of concentrations for which this technique is acceptable.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Gas absorption apparatus						x		
Analytical balance						x		
Hot plate						x		
Beakers						x		
Volumetric flasks						x		
Buret						x		
1 liter bottle						x		
Zinc acetate [$Zn(C_2H_3O_2)_2$]						x		
Nitrogen gas (N_2)						x		
Sulfuric acid (H_2SO_4)						x		
Iodine (I_2)						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		
Hydrochloric acid (HCl)						x		
Starch						x		
Aluminum chloride ($AlCl_3$)						x		
Sodium hydroxide (NaOH)						x		

Specific Conductance

ENV SCI 201(6):1-8(81-83)

PURPOSE

This guide will assist you in determining the specific conductance of a water or wastewater. The specific conductance of a water sample is affected by the various types of substances dissolved in that sample and by their relative concentrations. Fluctuations in the daily results are of interest to wastewater treatment plants, as they may indicate an influx of dissolved electrolytes. IRIS 4 lists a number of the practical applications for specific conductance.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36); and Env Sci 101:1a,b,c(49).

RESOURCES

IRIS: 4, 289, 291, 1036
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for specific conductance samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate specific conductance sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a specific conductance sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample

g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a specific conductance sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a specific conductance sample.

COND: Given resources (IRIS 4) and the time interval (up to 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a specific conductance analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in umhos/cm) for specific conductance.
g. Describe the procedure for determining the cell constant.
h. Determine the specific conductance for each sample.

OBJ 7: Report and interpret the specific conductance results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the specific conductance with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including errors resulting from carry-over from one sample to the next. Include an explanation of the procedure to be followed for samples which differ in conductivity by a factor of 5 or more from the KCl standard.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml sample bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Water bath						x		
Conductance instrument						x		
Balance						x		
Beakers						x		
Volumetric flasks						x		
Graduated cylinders						x		
Thermometer						x		
Potassium chloride						x		

Temperature

ENV SCI 201(7):2,6-8(81-83)

PURPOSE

This guide will assist you in determining the temperature of any water or wastewater. Temperature is one of the most important regulators of natural processes within the water environment. It governs physiological functions in organisms, and, acting directly or indirectly in combination with other water quality constituents, it affects aquatic life with each change. In this guide you will:

1. calibrate a thermometer and temperature meter;
2. learn how to change from ^{o}C to ^{o}F;
3. learn how to take the surface temperature of water;
4. learn how to take the temperature at any depth in a body of water.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46b(36).

RESOURCES

IRIS: 282, 283, 284, 1886, 2116
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Select appropriate temperature sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining representative data

OBJ 2: Describe and perform a temperature analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.
Include:

a. Calibrate the thermometer.
b. Record the temperature of various water bodies.
c. List the equipment and supplies.
d. List the analytical supplies.
e. Describe routine procedures for recording data.
f. Describe safety procedures.
g. Describe the calculations for the interconversion of ^{o}C and ^{o}F.
h. Determine the temperature for each depth.

OBJ 3: Report and interpret the temperature results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Plotting the temperature (in ^{o}C) against the depth.
b. Explaining the significance of the shape of the curve.
c. Comparing the curve with results of other groups.

OBJ 4: Recognize an abnormal condition in any of the data and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from.

a. Velocity of flow
b. Eddying
c. Stagnation
d. Influence of sunlight
e. Discharges of processes external to body of water

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Thermometer		x						
Water sampler		x						
Bunsen burner		x						
Beakers		x						
Ring stand		x						
Rowboat	x	x						
Ice		x						
Graph paper		x	x	x				
Isopropyl alcohol		x						

Turbidity

ENV SCI 201(8):1-8(81-83)

PURPOSE

This guide will assist you in determining the turbidity of a water or wastewater using a turbidity meter. Turbidity tests are performed for three reasons:

1. they help determine the cost of treatment of water supplies (when turbidity is high the cost of filtration increases);
2. they help to monitor and provide the clear, clean water that consumers demand (the upper limit is 5 units of turbidity);
3. they measure to what degree the pathogenic organisms in water may be encased in turbidity particles. (The higher the degree of encasement the lower the effectiveness of the disinfectant.)

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47j(37); and Env Sci 101: 1a(49) and 2a,b(49).

RESOURCES

IRIS: 4, 547, 1036, 1823
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for turbidity samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate turbidity sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a turbidity sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)

e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a turbidity sample to the laboratory.

COND: Given resources (IRIS 4) and the appropriate interval (as soon as possible, but not longer than 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a turbidity sample.

COND: Given resources (IRIS 4) and the appropriate time interval (as soon as possible, but no longer than 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a turbidity analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations for turbidity (NTU).
g. Determine the turbidity for each sample.

OBJ 7: Report and interpret the turbidity results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the turbidity with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Floating debris
b. Air bubbles
c. Color

Include an explanation of the procedure to be followed for measurement of samples having turbidity outside the range of the laboratory analysis.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml sample bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Turbidimeter						x		
Membrane filter apparatus						x		
Membrane filters (0.45)						x		
Volumetric flasks						x		
Hydrazine sulfate ($H_2NNH_2 \cdot H_2SO_4$)						x		
Hexamethylenetetramine						x		

Total Alpha and Beta Radioactivity in Water

ENV SCI 201(9,10):1-8(81-83)

PURPOSE

This guide will help you learn to determine total alpha and beta radioactivity. This information is of value in measuring both the natural radioactivity present in groundwaters and the artificial radioactivity in rain or streams. The analysis of total alpha and beta radioactivity may be invaluable in giving a fast indication of radioactive contamination.

PREREQUISITES

Before beginning this guide you should have successfully completed Chem 101:8, 37,45,46,47(30-37); Env Sci 101:1,2(49); Chem 102:22,23,26e,f,g(61) and Chem 201: 9(86).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for collecting and counting alpha and beta radiations.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: All containers should be free of radioactive contamination, giving background count rates.

OBJ 2: Describe and demonstrate the procedure for collecting a sample for total alpha and beta radioactivity analysis.

COND: Given resources (IRIS 4), an equipped laboratory, and a location.

PL: The sample should be taken so as not to exclude heavy metals or dissolved gases.

OBJ 3: Describe and demonstrate the procedure for transporting a sample to the laboratory for analysis of total alpha and beta.

COND: Given resources (IRIS 4).

PL: 95% of the samples must be suitable for analysis. Each sample should be handled so as to minimize loss resulting from:

a. Gases
b. Adsorption of radionuclides on container walls
c. Radioactive decay of short-lived nuclides

OBJ 4: Describe and demonstrate the procedure for storage of samples in the laboratory for the analysis of total alpha and beta radioactivity.

COND: Given resources (IRIS 4) and the time interval for storage.

PL: 95% of the samples should be suitable for analysis, including no loss of radioactive gases, no adsorption on container walls, and a minimum of loss resulting from radioactive decay.

OBJ 5: Select appropriate sample locations in a plant or watercourse for

analysis of total alpha and beta radioactivity.

COND: Given resources (IRIS 4) and information about possible sources of contamination.

PL: The locations chosen should yield information about source of contamination, direction and rate of movement of radionuclides, and rate of dilution of radionuclides.

OBJ 6: Describe and perform the analysis for total alpha and beta radioactivity, including proper safety procedures.

COND: Given resources (IRIS 4), the instrument manuals for equipment, and an equipped laboratory.

PL: 90% of samples must fall in acceptable range. Care to prevent loss and contamination must be maintained in each step. Self-absorption corrections must be done.

OBJ 7: Describe and perform the procedure for analyzing, reporting, and interpreting the results of the analysis for total alpha and beta radioactivity.

COND: Given resources (IRIS 4) and standard data.

PL: 90% of results must be correct.

OBJ 8: Recognize an abnormal condition in the analysis for total alpha and beta radioactivity and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4), the laboratory control operational guide for the plant, standard data, and the laboratory logbook.

PL: 80% of abnormal conditions must be spotted and corrected to meet standards listed in IRIS 4.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Internal proportional counter (or thin window G-M or proportional counter)						x		
Sample bottle	x	x	x	x		x		
Beakers (250, 500 or 1000 ml)						x		
Aluminum counting pans						x		
Hot plate (or heat lamp)						x		
Oven						x		
Desiccator						x		
Rubber policeman						x		
Wash bottle						x		
Distilled water						x		
Hydrochloric acid (HCl)						x		
Nitric acid (HNO_3)						x		
Methyl orange indicator						x		
Lucite solution						x		
Ethyl alcohol						x		
Standard cesium - 137 solution						x		
Hydrogen peroxide (H_2O_2)						x		

Total Radium

ENV SCI 201(11):1-4,6-8(81-83)

PURPOSE

This guide will assist you in learning to determine the total radium content of water. The precipitation method for analyzing radium content is applicable to clean water, but can be adapted to sewage or waste streams by destroying organic matter. This method can be used to determine whether the radium content is above or below that allowed for human use.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:8, 37,45,46,47(30-37); Chem 102:22,23,26e, f,g(61); Env Sci 101:1,2(49); and Chem 201:9(86).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for collecting and counting radium.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: All containers should be free of radioactive contamination, giving background count rates.

OBJ 2: Describe and demonstrate the procedure for collecting a sample for radium analysis.

COND: Given resources (IRIS 4), an equipped laboratory, and the sampling location.

PL: 90% should meet specifications.

OBJ 3: Describe and demonstrate the procedure for transporting a sample to the laboratory for radium analysis.

COND: Given resources (IRIS 4).

PL: The sample should be handled so as to give no radioactive contamination and to allow no adsorption or precipitation of heavy metals.

OBJ 4: Describe and demonstrate the procedure for storing samples in the laboratory for radium analysis.

COND: Given resources (IRIS 4) and the time interval for storage.

PL: 95% of samples should be suitable for analysis, with no adsorption or precipitation of heavy metals.

OBJ 5: Describe and perform the analyses for radium, including proper safety procedures.

COND: Given resources (IRIS 4), the instrument manuals, and an equipped laboratory, including a radium-226 standard.

PL: 90% of samples must fall within ± 20, and care must be maintained in each step to prevent loss or contamination.

OBJ 6: Describe and perform the procedure for analyzing, reporting, and interpreting the results of the radium analysis.

COND: Given resources (IRIS 4) and a standard radium-226 data.

PL: 90% of results must be correct.

OBJ 7: Recognize an abnormal condition in the radium analysis and suggest and take steps necessary to correct the abnormal condition.

COND: Given resources (IRIS 4) and the data.

PL: 80% of abnormal conditions must be identified and corrected to meet standards listed in IRIS 4.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Internal proportional counter (or similar alpha counter)						x		
Membrane filter holder						x		
Membrane filter						x		
Sample bottles	x	x	x	x		x		
1500 ml beaker						x		
Hot plate						x		
Stirrer						x		
Centrifuge						x		
Steam bath						x		
Planchet (stainless steel)						x		
Heat lamp						x		
Oven						x		
Mylar film						x		
Balance						x		
Medicine droppers						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
40 ml centrifuge tubes						x		
Distilled water						x		
Citric acid						x		
Ammonium hydroxide (NH_4OH)						x		
Lead nitrate [$Pb(NO_3)_2$]						x		
Barium chloride ($BaCl_2$)						x		
Methyl orange						x		
Phenolphthalein						x		
Bromcresol green						x		
Sulfuric acid (conc. H_2SO_4)						x		
Nitric acid (conc. HNO_3)						x		
EDTA						x		
Acetic acid (conc. $HC_2H_3O_2$)						x		
Ethyl alcohol (95)						x		
Acetone						x		
Lucite solution						x		
Standard radium-226						x		

SVI-SDI

ENV SCI 201(12):1-8(81-83)

PURPOSE

This guide will assist you in determining the sludge volume index (SVI) and the sludge density index (SDI). The SVI is the volume in milliliters occupied by 1 g of activated sludge after settling the aerated liquor for 30 minutes. The SDI is the reciprocal of the SVI multiplied by 100. The settleability of the activated sludge as measured by these two tests demonstrates the absorptive capacity, the general character, the age, and the tendency to bulk. A satisfactory sludge usually has an SVI in the range of 40-120.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101: 2a(49).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for SVI-SDI samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate SVI-SDI sample location in a wastewater treatment plant.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting an SVI-SDI sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting an SVI-SDI sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 30 minutes) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature

OBJ 5: Describe and demonstrate the procedure for storing an SVI-SDI sample.

COND: Given resources (IRIS 4) and the time interval for storage.

PL: 95% of samples must be suitable for analysis.

OBJ 6: Describe and perform an SVI-SDI analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the equipment.
b. Describe routine procedures for recording data.
c. Describe safety procedures.
d. Describe the calculations for SVI-SDI.
e. Determine the SVI and SDI for each sample.

OBJ 7: Report and interpret the SVI-SDI results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the SVI-SDI values with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in resource.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
1000 ml graduated cylinder						x		
Timer						x		
Calculator						x		

Percent Methane

ENV SCI 201(13):1-8(81-83)

PURPOSE

This guide will help you in determining the percent of CH_4 in a water sample. This analysis is needed in order to prevent the buildup of an explosive atmosphere by methane being trapped in a closed space.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101 (29-37) and Env Sci 101:1(49).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sampling for CH_4 analysis.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of sample containers must meet the specifications in IRIS 4, including that only glass containers should be used.

OBJ 2: Describe and demonstrate the procedure for collecting a sample for CH_4 analysis.

COND: Given resources (IRIS 4) and the location.

PL: 90% of the samples collected must be taken in conformance with procedures in one of the resources, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency

OBJ 3: Describe and demonstrate the procedure for transporting a sample to the laboratory for CH_4 analysis.

COND: Given resources (IRIS 4) and the time interval for transportation.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in IRIS 4.

OBJ 4: Describe and demonstrate the procedure for storing samples in the laboratory for CH_4 analysis.

COND: Given resources (IRIS 4) and the storage time required.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 5: Select appropriate sample location in plant or on watercourse for CH_4 analysis.

COND: Given resources (IRIS 4) and the nature of the water under study.

PL: Include:

a. Location in plant
b. Location in process unit or on stream
c. Depth

OBJ 6: Describe and perform the analysis for methane analysis, including proper safety procedures.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of the samples must fall within an acceptable range as defined in one of the resources. Safety procedures must be followed 100% of the time.

OBJ 7: Describe and perform the procedure for analyzing, reporting, and interpreting the results from a laboratory analysis for methane analysis.

COND: Given resources (IRIS 4) and the data.

PL: 90% of results must be correct and 80% of interpretation must conform to those in the resources.

OBJ 8: Recognize an abnormal condition in the CH_4 analysis in any performance in objectives 1-7 and suggest and take the action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4), standard data, and data for the system under study.

PL: 80% of abnormal conditions must be spotted and corrected to meet performance level in objectives 1-7.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Combustible gas indicator						x		
Vacuum pump						x		
4 liter bottle						x		
2-hole rubber stopper						x		
Glass tubing						x		
Stopcocks, 2- and 3-way						x		
Sample bottles	x	x	x	x		x		
Sodium hydroxide (NaOH)						x		

Sludge Age

ENV SCI 201(14):1-8(81-83)

PURPOSE

This guide will assist you in determining the sludge age for any aeration process. The sludge age is a measure of the time a particle of suspended solid has been undergoing aeration, and it is expressed in terms of days. Various measures of sludge age are available, but this guide will demonstrate the use of the Gould Sludge Age.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:46b, f(36) and 47a(36); Env Sci 101:1a,b,c,d (49); and Env Sci 102(4-7):1-8(69-71).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sludge age samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate sludge age sample locations in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting sludge age samples.

COND: Given the nature of the samples (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of representative samples
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting sludge age samples to the laboratory.

COND: Given resources (IRIS 4) and the interval (usually less than 30 minutes) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals

OBJ 5: Describe and demonstrate the procedure for storing sludge age samples.

COND: Given resources (IRIS 4) and the time interval (usually less than 30 minutes) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a sludge age analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the equipment.
b. List the analytical supplies.
c. Describe routine procedures for recording data.
d. Describe safety procedures.
e. Describe the calculations (in *days*) for sludge age.
f. Determine the sludge age for the process.

OBJ 7: Report and interpret the sludge age results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Calculating the sludge age for the process.
b. Comparing the value with the results of other groups performing the same analysis.
c. Comparing the value with performance standards for the process.
d. Explaining why any disagreement in results might occur.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including any interferences.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Balance						x		
Muffle furnace						x		
Crucible tongs						x		
Desiccator						x		
Gooch crucible						x		
Gravity oven						x		
Glass filter disk						x		
Suction flask						x		
Crucible holder						x		
Wash bottle						x		
Graduated cylinders						x		

Sludge Filterability (Sludge Conditioning)

ENV SCI 201(15):1-8(81-83)

PURPOSE

This guide will assist you in determining the amounts of chemicals needed for dewatering treatment of sludges, using filtration. Chemical treatment is used for two reasons:

1. it may coagulate the colloidal particles which clog the filter pores;
2. it may free any water chemically bound to the particles and thus facilitate drying by suction.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47a(36); and Env Sci 101: 1a,b,c,d(49) and 2a,b,c(49).

RESOURCES

IRIS: 125, 1426, 2075;
"Laboratory Procedures for Wastewater Treatment Plant Operators" NYSDEC.

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sludge filterability samples.

COND: Given resources and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in resources, including that no beads of water will be evident.

OBJ 2: Select appropriate sludge filterability sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources, wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sludge filterability sample.

COND: Given the nature of the sample (grab, composite), resources, the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in resources, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Collection of a representative sample
f. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sludge filterability sample to the laboratory.

COND: Given resources and the interval (usually less than 30 minutes) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in resources, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a sludge filterability sample.

COND: Given resources and the time interval (usually less than 30 minutes) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a sludge filterability analysis, including proper safety procedure.

COND: Given resources and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in resources. Safety procedures must be followed 100% of the time. Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in *seconds*) for filtration.
g. Determine the sludge filterability for each sample.

OBJ 7: Report and interpret the sludge filterability results using established technical report form.

COND: Given resources.

PL: 90% of results must be correct and 80% of interpretation must conform to those in resources. Results will be interpreted by:

a. Showing the effectiveness of chemical addition.
b. Showing the quantity of chemicals to be added.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action.

COND: Given resources.

PL: 80% of abnormal conditions must be spotted and corrected.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Bank mixer						x		
Analytical balance						x		
Stop watch						x		
Buchner funnel						x		
Vacuum pump						x		
Graduated cylinders						x		
Beakers						x		
Pipets						x		
Suction flask						x		
Filter paper						x		
Ferric chloride ($FeCl_3$)						x		
Hydrated lime						x		

Sulfate

ENV SCI 201(16):1-8(81-83)

PURPOSE

This guide will assist you in determining the sulfate content of a water or wastewater using gravimetric techniques. The sulfate test is performed for two reasons:

1. it can show whether the sulfate level exceeds the U.S. Public Health limit of 250 mg/l in waters used for human consumption. This level is established because of the cathartic action of sodium and magnesium sulfate;
2. it provides information regarding the odor forming and corrosion causing properties of the sample as indicated by the following equations:

$$SO_4^- + \text{organic matter} \xrightarrow[\text{bacteria}]{\text{anaerobic}} S^- + H_2O + CO_2$$

$$S^- + 2H^+ \rightleftharpoons H_2S \text{ (rotten egg odor)}$$

$$H_2S + 2O_2 \xrightarrow{\text{bacteria}} H_2SO_4 \text{ (acid to cause corrosion)}$$

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47j(37); and Env Sci 101: 1a,b,c,d,h(49) and 2a,b,d(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sulfate samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate sulfate sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sulfate sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sulfate sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Cooling
d. Adjustment of pH

OBJ 5: Describe and demonstrate the procedure for storing a sulfate sample.

COND: Given resources (IRIS 4) and the time interval (up to 7 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a sulfate analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Prepare and standardize the necessary reagents.
f. Describe safety procedures.
g. Describe the calculations (in mg/l) for sulfate.
h. Determine the sulfate content for each sample.

OBJ 7: Report and interpret the sulfate results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in resource 4. The results will be interpreted by:

a. Comparing the sulfate concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the result in terms of human health.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Suspended matter
b. Silica
c. Barium chloride
d. Nitrate
e. Sulfite
f. Occluded water
g. Alkali metal sulfates
h. Heavy metals
i. Alkali hydrogen sulfates
j. Iron
k. Copper

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Steam bath						x		
Drying oven						x		
Muffle furnace						x		
Desiccator						x		
Analytical balance						x		
Ion-exchange column						x		
Hot plate						x		
Crucible (gooch)						x		
Evaporating dish						x		
GFC filter paper						x		
Methyl red indicator						x		
Hydrochloric acid (HCl)						x		
Barium chloride ($BaCl_2$)						x		
Silver nitrate ($AgNO_3$)						x		
Nitric acid (HNO_3)						x		

Sulfite

ENV SCI 201(17):1-8(81-83)

PURPOSE

This guide will assist you in determining the sulfite content of a water or wastewater, using potassium iodide-iodate as the titrant. The sulfite test is most commonly used to assure that the sulfite ion concentration in boilers is high enough to prevent corrosion, but it may also be used for other waters whose sulfite concentration is desired.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47f(36); and Env Sci 101: 1a,b,c,g(49) and 2a,b,d(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sulfite samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate sulfite sample location in a wastewater treatment plant, watercourse, or process unit.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sulfite sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample

g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sulfite sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light
c. Addition of preservative chemicals.

OBJ 5: Describe and demonstrate the procedure for storing a sulfite sample.

COND: Given resources (IRIS 4).

PL: No holding time is allowed for sulfite samples. The determination must be performed on site and as rapidly as possible.

OBJ 6: Describe and perform a sulfite analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in mg/l SO_2) for sulfite.
g. Determine the sulfite content for each sample.

OBJ 7: Report and interpret the sulfite results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the sulfite concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results.

OBJ 8: Recognize any abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Organic matter
b. Sulfide
c. Nitrite
d. Copper
e. Heavy metals
f. Ferrous iron

Use Dual-Purpose Dry Starch Indicator Powder (if available) to minimize interference.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Oven						x		
Desiccator						x		
Balance						x		
Flasks						x		
Beakers						x		
Buret						x		
Graduated cylinders						x		
Volumetric flasks						x		
Sulfuric acid (H_2SO_4)						x		
Starch indicator						x		
Salicylic acid						x		
Potassium iodate (KIO_3)						x		
Potassium iodide (KI)						x		
Sodium bicarbonate ($NaHCO_3$)						x		

Bromide

ENV SCI 201(18):1-8(81-83)

PURPOSE

This guide will assist you in determining the bromide content of water or wastewater, using the spectrophotometer. The bromide test is important because the presence of bromide in excess of 1 mg/l may indicate industrial pollution or sea water intrusion.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47f(36); and Env Sci 101: 1a,b,c,g(49) and 2a,b,d(49).

RESOURCES

IRIS: 4
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for bromide sample.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate bromide sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a bromide sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling of equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a bromide sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a bromide sample.

COND: Given resources (IRIS 4) and the time interval (as soon as possible, but not over 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a bromide analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in mg/l Br) for bromide.
g. Determine the bromide content for each sample.

OBJ 7: Report and interpret the bromide results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the bromide concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Iron
b. Manganese
c. Organic matter
d. Color

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Acetic acid ($HC_2H_3O_2$)						x		
Bromide (Br)						x		
Calcium carbonate ($CaCO_3$)						x		
Calcium hypochlorite [$Ca(OCl)_2$]						x		
Calcium oxide (CaO)						x		
Hydrochloric acid (HCl)						x		
Potassium iodide (KI)						x		
Amylose indicator						x		
Chloroform						x		
Nitrogen gas (N_2)						x		
Sodium acetate trihydrate ($NaC_2H_3O_2 \cdot 3H_2O$)						x		
Sodium chloride (NaCl)						x		
Sodium formate (HCO_2Na)						x		
Sodium molybdate (Na_2MoO_4)						x		
Sulfuric acid (H_2SO_4)						x		
Phenylarsine oxide						x		
Potassium biiodate [$KH(IO_3)_2$]						x		
Sodium thiosulfate ($Na_2S_2O_3$)						x		
Starch						x		
Potassium fluoride (KF)						x		

Chloride

ENV SCI 201(19):1-8(81-83)

PURPOSE

This guide will assist you in determining the chloride content of a water or wastewater, using the argentometric method. The detection of chloride is important not only because of the undesirable salty taste it imparts to water, but also because of its harmful effect on agricultural plants.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46e,f(36) and 47f(36); and Env Sci 101: 1a,b,c,g(49) and 2a,b,d(49).

RESOURCES

IRIS: 4, 41, 1915;
"Methods for Chemical Analysis of Water and Wastes" (IRIS number not yet assigned).

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for chloride samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate chloride sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a chloride sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample

g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a chloride sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (up to 7 days) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a chloride sample.

COND: Given resources (IRIS 4) and the time interval (up to 7 days) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a chloride analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the reagents.
b. List the equipment.
c. List the analytical supplies.
d. Describe routine procedures for recording data.
e. Describe safety procedures.
f. Describe the calculations (in mg/l Cl) for chloride.
g. Determine the chloride content for each sample.

OBJ 7: Report and interpret the chloride results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Comparing the chloride concentration with results of other groups performing the same analysis.
b. Explaining why any disagreement in results might occur.
c. Describing the significance of the results in relation to information given in IRIS 4.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Sulfide
b. Thiosulfate
c. Sulfate
d. Orthophosphate
e. Iron
f. Bromide
g. Iodide
h. Cyanide

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Hot plate						x		
Balance						x		
Distiilation apparatus						x		
Oven						x		
Desiccator						x		
Brown bottles						x		
Graduated cylinders						x		
Beakers						x		
Buret						x		
Volumetric flasks						x		
500 ml bottles (2)	x	x	x	x	x	x		
Sample carrier				x				
Potassium chromate ($KCrO_4$)						x		
Silver nitrate ($AgNO_3$)						x		
Sodium chloride (NaCl)						x		
Aluminum hydroxide [$Al(OH)_3$]						x		
Phenophthalein indicator						x		
Sodium hydroxide (NaOH)						x		
Sulfuric acid (H_2SO_4)						x		
Hydrogen peroxide (H_2O_2)						x		

Percent Free CO_2

ENV SCI 201(20):1-4,6-8(81-83)

PURPOSE

This guide will assist you in determining the free CO_2 content of any water or wastewater. The CO_2 content must be carefully maintained in many uses because a loss of CO_2 can lead to precipitation of metal carbonates, and a gain of CO_2 can lead to faster corrosion.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101(29), Chem 102(57), and Env Sci 101:1(49).

RESOURCES

IRIS: 4, 481, 488.

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for sampling for CO_2 analysis.

COND: Given resources and an equipped laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4 or 481, including no trace of acid or base or organic matter.

OBJ 2: Describe and demonstrate the procedure for collecting a sample for CO_2 sample location.

COND: Given resources, the nature and reason for the sample, and a plant operation guide.

PL: 90% of the samples collected must conform to procedures in one of the resources, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency

OBJ 3: Describe and demonstrate the procedure for transporting a sample to the laboratory for CO_2 sample.

COND: Given resources, the location, and the necessary equipment and supplies.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures described in one of the resources.

OBJ 4: Describe and demonstrate the procedure for storing CO_2 samples in the laboratory for analysis.

COND: Given resources, the time interval before analysis, and necessary equipment and supplies.

PL: The analysis must be run as soon as possible; 90% of the samples must be suitable for analysis.

OBJ 5: Select appropriate sample location in plant or on watercourse for CO_2 sample.

COND: Given resources, the time interval before analysis, and necessary equipment and supplies.

PL: The analysis must be run as soon as possible; 90% of the samples must be suitable for analysis.

OBJ 6: Describe and perform the analysis for a free CO_2 analysis, including proper safety procedures.

COND: Given resources and an equipped laboratory.

PL: 90% of the samples must fall within acceptable range as defined in IRIS 4 or 481. Safety procedures must be followed 100% of the time. Also, description should include the effect of traces of acid or base on the analysis and the CO_3^{-2} - HCO_3^- - H_2CO_3 relationships to the free CO_2 analysis.

OBJ 7: Describe and perform the procedure for analyzing, reporting, and interpreting the results from a laboratory analysis for the free CO_2 analysis.

COND: Given resources and a range of acceptable values.

PL: 90% of results must be correct and 80% of interpretation must conform to those in the resources.

OBJ 8: Recognize an abnormal condition in the free CO_2 analysis in any performance in objectives 1-6 and suggest and take the action necessary to correct the abnormal condition.

COND: Given resources, a range of acceptable values, and the laboratory logbook.

PL: 80% of abnormal conditions must be spotted and corrected to meet performance level objectives 1-7.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
pH meter						x		
250 ml beakers						x		
Sample bottles	x	x	x	x		x		
Stirring rod						x		
100 ml graduated cylinder						x		
Phenolphthalein						x		
Sodium hydroxide (NaOH)						x		

Grit Analysis

ENV SCI 201(21):1-8(81-83)

PURPOSE

This guide will assist you in determining the percentage of organic material found in grit, using methods learned in solids analysis. A pure grit, free from organic material, is most desirable, but it cannot be obtained from even the most carefully designed grit chamber. It is generally accepted that a grit of less than 5% putrescibility is satisfactory for ordinary disposal.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101: 46b,f(36) and 47a(36); Env Sci 101:1a,b, c,d(49); and Env Sci 102(4-7):1-8(69-71).

RESOURCES

IRIS: 4, 125, 830.

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for grit analysis samples.

COND: Given resources (IRIS 4) and an equipped wastewater laboratory.

PL: 90% of the sample containers must meet the specifications in IRIS 4, including that no beads of water will be evident.

OBJ 2: Select appropriate grit analysis sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a grit analysis sample.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Sampling equipment needed
b. Time of day
c. Frequency (retention time considered)
d. Collection of a representative sample
e. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a grit analysis sample to the laboratory.

COND: Given resources (IRIS 4) and the interval (usually less than 24 hours) from time of sampling to time of analysis.

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a grit analysis sample.

COND: Given resources (IRIS 4) and the time interval (usually less than 24 hours) over which the sample must be kept in the laboratory.

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a grit analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4. Safety procedures must be followed 100% of the time.

Include:

a. List the equipment.
b. List the analytical supplies.
c. Describe routine procedures for recording data.
d. Describe safety procedures.
e. Describe the calculations (in % organics) for grit analysis.
f. Determine the % organics for each sample.

OBJ 7: Report and interpret the grit analysis results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. Results will be interpreted by:

a. Calculating the percent organics.
b. Comparing the result with results of other groups performing the same analysis.
c. Explaining when any disagreement in results might occur.
d. Comparing the result with acceptable standards.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Carbon dioxide during ignition
b. Calcium oxide in the ash

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Analytical balance						x		
Muffle furnace						x		
Crucible tongs						x		
Desiccator						x		
Gravity oven						x		
Glass filter disk						x		
Suction flask						x		
Crucible holder						x		
Wash bottle						x		
Graduated cylinders						x		
Sample carrier				x				

Atomic Absorption Spectrophotometer

ENV SCI 202(1-28):1-8(95-97)

PURPOSE

This guide will assist you in learning to operate an atomic absorption spectrophotometer (AAS). An AAS, properly equipped for both absorption and emission studies, can determine the concentration of more than 70 elements over a wide concentration range. For a great many elements, detection limits by atomic absorption are better than any other instrumental technique, and a precision of better than 0.2% of the amount present can be achieved. In addition, there are relatively few interferences and sample preparation time is often minimal.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101: 1a,b,c,h(49) and 2a,b,c,d(49) and 3a(49).

RESOURCES

IRIS: 4, 538, 1429, 1795, 2143, 2144, 2145, 2146

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for analysis on the atomic absorption spectrophotometer.

COND: Given resources.

PL: 90% of the sample containers must meet the specifications in one of the resources, including:

a. No beads of water will be evident.
b. Container material to be of such chemical composition that it does not absorb or adsorb any of the components in the sample.

OBJ 2: Select appropriate sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Depth
d. Obtaining a representative sample

OBJ 3: Describe and demonstrate the procedures for collecting a sample for analysis on the atomic absorption spectrophotometer.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed

c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sample for analysis on the atomic absorption spectrophotometer to the laboratory.

COND: Given resources (IRIS 4) and the interval from time of sampling to time of analysis, including:

a. Less than 30 minutes
b. Four hours
c. Twelve hours
d. One day
e. Two days
f. One week

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a sample for analysis on the atomic absorption spectrophotometer.

COND: Given resources (IRIS 4) and the time interval over which the sample must be kept in the laboratory, including:

a. Six hours
b. One day
c. One week
d. One month
e. Six months

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform an atomic absorption spectrophotometer analysis, including proper safety procedure.

COND: Given resources (IRIS 4) and an equipped laboratory.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4 and other resources. Safety procedures must be followed 100% of the time.

Include:

a. Determine the linear working range for the sample.
b. Select the proper wavelength.
c. Select the proper slit setting.
d. Select the proper light source.
e. Select the proper flame type.
f. Prepare standard solution.
g. Determine the optimum gas flow.
h. List the equipment.
i. List the analytical supplies.
j. Describe routine procedures for instrument start-up and shut-down.
k. Describe routine procedures for recorder start-up, adjustment, and shut-down.
l. Describe routine procedures for recording data.
m. Describe safety procedures.
n. Describe the calculations in mg/l for determining the concentration of the element of interest in the original sample.
o. Determine the concentration of the element of interest in each sample.

OBJ 7: Report and interpret the atomic absorption results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4 and other resources.

Results will be interpreted by:

a. Determining the detection limits for each element.
b. Determining the composition of each element in the sample.
c. Comparing the results with existing analyses of similar samples.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take corrective action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including:

a. Chemical interference
b. Ionization interference
c. Spectral interference
d. Matrix interference
e. Background absorption
f. Error due to storage of the standard

Correct all abnormal conditions and produce a determination scheme which allows for rapid and reliable data collection.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Volumetric glassware						x		
Atomic absorption spectrophotometer						x		
Recorder						x		
Gravity oven						x		
Analytical balance						x		
Desiccator						x		
Filter paper						x		
Weighing paper						x		
Sampling boats						x		
Gas cylinders (fuel and air)						x		
Gas regulators						x		

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Tool kit						x		
Solvents (organic)						x		

Gas Chromatography

ENV SCI 202(30-36):1-8(95-97)

PURPOSE

This guide will assist you in learning to operate a gas chromatograph. Because of the complex nature both of this instrument and the chemicals it is able to analyze, specialized techniques must be utilized to best obtain the desired information. The validity of the data acquired from the gas chromatograph is primarily dependent on the operator's proficiency with the instrumental technique.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101: 2a,b,c,d(49) and 3a(49).

RESOURCES

IRIS: 4, 1755, 2134, 2135, 2136, 2137, 2138, 2139, 2141

OBJECTIVES

OBJ 1: Describe and demonstrate the procedure for the preparation of containers for samples for analysis on the gas chromatograph.

COND: Given resources.

PL: 90% of the sample containers must meet the specifications in one of the resources, including:

a. No beads of water will be evident.
b. Container material to be of such chemical composition that it does not absorb or adsorb any of the components in the sample.

OBJ 2: Select appropriate sample location in a wastewater treatment plant or on a watercourse.

COND: Given resources (IRIS 4), wastewater treatment plant operational guide or watercourse map, and the nature or reason for the sample, including:

a. Determining efficiency of process.
b. Meeting regulatory requirements.
c. Meeting a process requirement.

PL: Include:

a. Location in plant
b. Location in process unit or stream
c. Obtaining a representative sample
d. Depth

OBJ 3: Describe and demonstrate the procedures for collecting a sample for analysis on the gas chromatograph.

COND: Given the nature of the sample (grab, composite), resources (IRIS 4), the location, and the necessary equipment and supplies.

PL: 90% of the samples must be taken in conformance with procedures in IRIS 4, including:

a. Depth
b. Sampling equipment needed
c. Time of day
d. Frequency (retention time considered)
e. Absence of floating matter
f. Collection of a representative sample
g. Labeling of containers to show date, place, time, and name of person who collected sample

OBJ 4: Describe and demonstrate the procedure for transporting a sample for analysis on the gas chromatograph to the laboratory.

COND: Given resources (IRIS 4) and the interval from time of sampling to time of analysis, including:

a. Less than 30 minutes
b. Four hours
c. Twelve hours
d. One day
e. Two days
f. One week

PL: 95% of the samples arriving at the laboratory must be suitable for analysis in conformance with procedures prescribed in IRIS 4, including:

a. Control of temperature
b. Exclusion of light

OBJ 5: Describe and demonstrate the procedure for storing a sample for analysis on the gas chromatograph.

COND: Given resources (IRIS 4) and the time interval over which the sample must be kept in the laboratory, including:

a. Six hours.
b. One day
c. One week
d. One month
e. Six months

PL: 95% of the samples stored must be suitable for analysis after the prescribed storage time.

OBJ 6: Describe and perform a gas chromatograph analysis on the sample, including proper safety procedure.

COND: Given resources (IRIS 4), an equipped laboratory, and the type of compound to be detected.

PL: 90% of samples must fall within reasonable limits of deviation as defined in IRIS 4 and other resources. Safety procedures must be followed 100% of the time.

Include:

a. Select the proper columns and support phases.
b. Select the proper carrier gas.
c. Select the proper carrier gas pressure.
d. Select the proper carrier gas velocity and flow.
e. Select the proper injection system.
f. Select the proper detector.
g. Select the proper injector, column, and defector temperatures.
h. Select the most efficient temperature program.
i. List the equipment.
j. List the analytical supplies.
k. Describe routine procedures for instrument start-up and shut-down.
l. Describe routine procedures for recorder start-up, adjustment, and shut-down.
m. Describe routine procedures for recording data.
n. Describe safety procedures.
o. Describe the calculations for each component in a sample.
p. Determine the concentration of each component in the sample.

OBJ 7: Report and interpret the gas chromatography results using established technical report form.

COND: Given resources (IRIS 4).

PL: 90% of results must be correct and 80% of interpretation must conform to those in IRIS 4. The results will be interpreted by:

a. Determining the component corresponding to each distinct peak.
b. Determining the composition of each component.

c. Comparing the results with existing analyses of similar samples.

OBJ 8: Recognize an abnormal condition in any of the analyses and suggest and take action necessary to correct the abnormal condition.

COND: Given resources (IRIS 4).

PL: 80% of abnormal conditions must be spotted and corrected, including interferences resulting from:

a. Improper technique
b. Leakage through gas system
c. Background noise
d. Non-optimum column and detector combinations
e. Poor peak retention and/or resolution

Correct all abnormal conditions and produce a chromatogram which allows for rapid and reliable data collection.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
500 ml bottles (2)	x	x	x	x	x			
Sample carrier				x				
Syringes						x		
Syringe cleaner						x		
Gas chromatograph						x		
Recorder						x		
Gas cylinders (H_2, N_2, Air)						x		
Gas regulators (H_2, N_2, Air)						x		
Tool kit						x		
Solvents as listed in resources						x		

Inventory Systems

ENV SCI 203:1(89)

PURPOSE

This guide will assist you in learning to set up an inventory system. Inventory systems are developed and maintained to assure that a complete and continued stock of laboratory equipment and supplies is readily available. They are useful to assist in yearly budget projections, to minimize the expense of carrying and ordering materials, and to avoid deterioration of materials by exceeding their shelf life.

PREREQUISITES

None

RESOURCES

IRIS: 4
"Management and Supervision Procedures for Wastewater Facilities," Volume IV
US Environmental Protection Agency
Plant and Operating Budget
Equipment and Supplies Catalogs
Price List
PL 92-500
PL 93-523

OBJECTIVES

OBJ 1: Develop a checklist of information used to inventory consumable supplies and expendable equipment.

COND: Given budget limitations, the nature of the test to be performed (PL 92-500 and PL 93-523), the frequency and number of samples to be run.

PL: Include:

a. Annual plant budget
b. Bid specifications
c. Handling cost
d. Laboratory test and monitoring requirements
e. Shipping time
f. Present inventory
g. Annual usage and/or breakage
h. Number of laboratory personnel
i. Purchase procedure and time
j. Rate of material usage
k. Record keeping requirement
l. Safety regulations
m. Shelf life of materials
n. Storage space available

OBJ 2: Describe, compare, and select an appropriate inventory system.

COND: Given inventory systems, budget limitations, the nature of the test to be performed (PL 92-500, PL 93-523), the frequency and number of samples to be run.

PL: Include all the items in the check list of the performance level for OBJ 1.

OBJ 3: Perform the inventory.

COND: Given the selected inventory system and the check list.

PL: Include the balance of all consumable supplies and expendable equipment to assure a continuous supply as necessitated by usage within budget constraints.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Budget	x	x	x					
Catalogs	x		x					
Manufacturers' operating instructions	x							
Inventory	x	x						

Order Forms

ENV SCI 203:2(89)

PURPOSE

This guide will assist you in learning to use order forms to obtain equipment and supplies. These forms simplify ordering by assuring accuracy and standardization of ordering procedures and sequences, purchasing and receiving, and inventory control.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 203: 1(89).

RESOURCES

IRIS: 4
Equipment and Supplies Catalogs
PL 92-500
PL 93-523

OBJECTIVES

OBJ 1: List the resources and the information used to complete a purchase order.

COND: Given an inventory, budget limitations, test to be run, and component or units to be purchased.

PL: Include:

a. List the information used to justify and complete a purchase order (cover all items below):
   1. date
   2. delivery and installation times
   3. equipment name
   4. equipment priority
   5. f.o.b. information
   6. forms
   7. model number
   8. part number
   9. price
   10. purchase procedures
   11. serial number
   12. size
   13. tax
   14. warranty terms

b. List the resources for preparing a purchase order (cover all items below):
   1. catalogs
   2. design engineer's specifications
   3. listings of manufacturers
   4. manufacturers' operating instructions
   5. manufacturers' parts lists
   6. shop drawings
   7. telephone book

OBJ 2: Prepare a purchase order.

COND: Given inventory, budget limitations, test to be run, supplies, components or unit to be purchased, resource information, and a purchase order form.

PL: Include:

a. Justify the purchase, stating why the unit or component is important to laboratory operation or testing procedures.
b. Select the resources for completing the purchase order.
c. Locate the information used to complete the purchase order.
d. Complete purchase order forms for different units or components.

OBJ 3: Receive delivery of ordered supplies, components, or units purchased.

COND: Given the delivered supplies, components, packing slip, and purchase order.

PL: Include:

a. Check delivered merchandise against packing slip and purchase order.
b. Note discrepandies.
c. Initiate steps to correct errors.
d. Enter into inventory system, if accepted.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Price list	x	x						
Purchase order forms	x	x						
Inventory	x	x						
Budget	x	x						
Catalogs	x	x						
Listing of manufacturers	x	x						
Manufacturers' operating instructions		x						
Manufacturers' parts list	x	x						
Purchase order			x					
Packing slip			x					

Laboratory and Regulatory Reports

ENV SCI 203:3(89)

PURPOSE

This guide will assist you in learning how to prepare daily, monthly, and annual laboratory and regulatory reports. These reports are essential to meet the requirements for permits under the National Pollutant Discharge Elimination System.

PREREQUISITES

None

RESOURCES

IRIS: 108, 281, 381, 399, 1226, 1583, 2510

OBJECTIVES

OBJ 1: List the resources and kinds of information used to prepare daily, monthly, and annual monitoring reports.

COND: Given the monitoring program, list of reports required, report forms, budget limits, budget categories, and deadlines.

PL: Include:

a. List the points to consider when preparing daily, monthly, and annual monitoring reports (cover all items below):
   1. site visits
   2. frequency of site visits
   3 equipment and instrument performance
   4. material costs and purchases
   5. maintenance costs
   6. equipment and instrument costs
   7. operating costs
   8. personnel performance

b. List the information used to prepare daily, monthly, and annual monitoring reports (cover all items below):
   1. inventories of consumable supplies
   2. equipment and instrument records
   3. maintenance records
   4. log sheets
   5. person for whom report is prepared
   6. personnel records
   7. program modifications
   8. monitoring records
   9. purchasing methods
   10. purchase of report
   11. results of laboratory analyses
   12. timekeeping records
   13. utility costs

c. List the resources for preparing daily, monthly, and annual monitoring reports (cover all items below):
   1. effluent standards or receiving water standards
   2. equipment and instrument specifications
   3. monitoring program specifications
   4. shift schedules
   5. standard report forms

d. List the calculations used to prepare daily, monthly, and annual monitoring reports (cover all items below):
   1. effluent load to receiving waters
   2. personnel costs
   3. monitoring cost and efficiencies

OBJ 2: Prepare daily, monthly, and annual performance reports.

COND: Given the monitoring program, a list of the reports required, report forms, budget limits, budget categories, deadlines, the student's check lists, resources, records, and information.

PL: Include:
- a. Locate the information used.
- b. Select the resources.
- c. Perform the calculations.
- d. Prepare the reports.

OBJ 3: List the resources and kinds of information used to prepare reports under the National Pollutant Discharge Elimination System (NPDES) and other regulatory agency reports.

COND: Given the composite model plant, an NPDES permit, a list of the reports required, and report forms.

PL: Include:
- a. List the points to consider when preparing NPDES and other regulatory agency reports (cover all items below):
  1. loading on operational units
  2. machinery performance
  3. maintenance costs
  4. material costs and purchases
  5. operating costs
  6. personnel performance
  7. unit efficiencies
- b. List the information used to prepare NPDES reports and other regulatory agency reports (cover all items below):
  1. monitoring requirements
  2. operator log sheets
  3. plant records
  4. results of laboratory analyses
- c. List the resources for preparing NPDES reports and other regulatory agency reports (cover all items below):
  1. effluent standards or receiving water standards
  2. equipment specifications
  3. plant as-built prints
  4. plant design specifications
  5. plant specificiations
  6. shift schedules
  7. standard report forms
- d. List the calculations used to prepare NPDES reports and other regulatory agency reports (cover all items below):
  1. effluent load to receiving waters
  2. percentage of design expectations
  3. personnel costs
  4. unit and plant loading rates and efficiencies
  5. unit cost

OBJ 4: Prepare NPDES reports and other regulatory agency reports.

COND: Given the composite model plant, a list of the reports required, report forms, the student's check lists, resources, plant records, and information.

PL: Include:
- a. Locate the information.
- b. Select the references.
- c. Perform the calculations.
- d. Prepare the reports.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
NPDES forms	x	x	x	x				
State forms	x	x	x	x				
Report forms	x	x	x	x				
Budgets	x							
Log sheets	x							

Training Lab Personnel

ENV SCI 203:4(89-90)

PURPOSE

This guide will assist you in developing techniques which can be used in training new laboratory personnel or in upgrading experienced personnel. Instruction of laboratory trainees is often required of laboratory personnel. This instruction takes many forms and may include how to use an instrument, how to do analytical techniques, how to fill out standard forms or a host of other functions, all necessary for the efficient running of a laboratory or monitoring program.

PREREQUISITES

None

RESOURCES

"Preparing Instructional Objectives" by Robert F. Mager
"Developing Attitude Toward Learning" by Robert F. Mager
"Analyzing Performance Problems" by Robert F. Mager
NTOTC EPA Course 180, "Instructional Resources"

OBJECTIVES

OBJ 1: Define:
- a. Instructional objective
- b. Acceptable performance
- c. Behavior
- d. Criterion

COND: Given resource: Robert Mager's "Preparing Instructional Objectives."

PL: Include the meaning of the terms, their role in the design of instructional programs, and how they relate to achieving a desired state in the learner.

OBJ 2: List 10 performance verbs that are specific in their interpretation.

COND: Using any available resources in any subject.

PL: Include only words that are so specific that their instructional intent cannot be misconstrued--such words as "list," "write," "demonstrate," and "provide."

OBJ 3: Identify five types of performance statements that can be clearly tested to show that the learner has achieved the objective.

COND: Using any books or other materials available to you and within the context of the material to be learned.

PL: Included in each performance statement must be a clear communication to the learner of the kind of response that will be expected of him when he is tested. It should describe the educational intent, note what the learner must do to achieve the objective, and the skill to be learned.

OBJ 4: Define the terminal behavior* of an objective so that it demonstrates

*Throughout this *Learner's Guide*, the terminal behavior is indicated by the performance level (PL) for each objective (OBJ).

to the learner the information that must be learned if mastery of the objective is achieved. (How well you expect him to be able to do it.)

COND: Using any books or other materials available to you and within the context of the material to be learned.

PL: Include in the definition a clear specification of the minimum acceptable performance for each objective. It must provide you with a method of determining if your program is successful in achieving your instructional intent. Words should be used that describe the criterion of success. In many cases, these may be a limiting time factor, a description of what the end product will look like, a minimum number or percentage or an acceptable deviation or other phase that clearly shows the intended outcome.

OBJ 5: Describe and demonstrate the use of 35mm projectors and slides, 8mm and 16mm movie film and projector, filmstrips and projectors, and overlays and overhead projectors.

COND: Given a laboratory or classroom equipped with the necessary audio-visual materials and equipment.

PL: Correct usage of this equipment.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Mager's "Preparing Instructional Objectives"	x							
35mm projector and slides					x			
16mm projector and film					x			
Filmstrip projector and filmstrips					x			
Overhead projector and overlays					x			

Types of Monitoring Programs

ENV SCI 204:1(99)

PURPOSE

This guide will assist you in learning the various types of monitoring and surveillance programs that are carried out in water quality studies. Water courses are analyzed for many reasons, including the desire for information on the flow, water quality, suitability for particular uses, and diversity of aquatic life present. The manager of a water quality laboratory must be familiar with the many types of analyses the lab might have to conduct.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 201(85), Env Sci 201(81), Env Sci 203(89) and Eng 102(91).

RESOURCES

IRIS: 879, 1331, 1332

OBJECTIVES

OBJ 1: List at least 12 types of monitoring and surveillance programs.

COND: Given three resources.

PL: Include at least 12 of the following:

a. Establishment of a base-line record of water quality.
b. Investigation of suitability as a source of municipal, industrial or other water supply.
c. Investigation of suitability for recreational use.
d. Investigation of suitability for propagation of aquatic life.
e. Day to day monitoring of raw water sources of municipal, industrial, and other water supply.
f. Monitoring effects of waste discharges.
g. Surveillance to detect adherence to or violation of water quality standards.
h. Detection of sudden changes in water quality caused by slugs of wastes resulting from spills, deliberate discharges or treatment plant failures.
i. Determination of patterns of pollution downstream from waste discharges and effects on water uses.
j. Determination of adherence to or violation of water quality standards.
k. Determination of characteristics and rates of natural purification of streams.
l. Projection of effects of pollution on conditions of flow and temperature other than those occurring during study.
m. Estimation of waste assimilation capacities of streams.
n. Estimation of reductions in waste loads necessary to meet water quality requirements.
o. Determination of causes of fish kills or other disasters involving deterioration of water quality.
p. Determination of existing water quality before some change in

conditions, such as a new or increased waste discharge or impoundment of a reservoir.

EQUIPMENT AND SUPPLIES

None

Review of Historical Records

ENV SCI 204:1,PL 1(99)

PURPOSE

This guide will assist you in finding resource material which will be helpful in obtaining background material for water quality studies. In planning environmental monitoring programs it is wise to review previous efforts on the same body of water or similar ones. This will usually lead to more pertinent data from the survey.

PREREQUISITES

None

RESOURCES

IRIS: 1331

OBJECTIVES

OBJ 1: Select resource material that contains historic data on the proposed survey area.

COND: Given resource material.

PL: Include material from such sources as:

a. U.S. Geological Survey
b. U.S. Bureau of Reclamation
c. U.S. Army Corps of Engineers
d. State water pollution control agency
e. State water survey
f. U.S. Environmental Protection Agency or U.S. Public Health
g. Professional journals
h. State natural history
i. State academy of science

OBJ 2: Select material from resources relevant to planned survey.

COND: Given survey plan and resources.

PL: Include such information as:

a. Tables
b. Charts
c. Figures
d. Models
e. Predictive equations
f. Techniques
g. Analysis and evaluation

EQUIPMENT AND SUPPLIES

None

Physical Characteristics of a Body of Water

ENV SCI 204:1,PL 2(99)

PURPOSE

This guide will assist you in determining the effects of physical characteristics of a body of water on its ability to purify itself. The physical characteristics of a body of water strongly affect its ability to reduce pollutants by means of natural purification. Knowledge of these characteristics is necessary for planning and interpreting the data from a survey.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204:1,PL 1(99).

RESOURCES

IRIS: 879, 1331, 1332

OBJECTIVES

OBJ 1: List the features of vertical, lateral, and longitudinal mixing that affect the distribution of pollutants in a body of water.

COND: From recall.

PL: Include:

a. Effect of: turbidity, temperature, depth, velocity, turbulence, slope, changes in direction and cross section, nature of bottom (roughness)
b. Causes of: laminar flow, turbulent flow, stratification

OBJ 2: List the features of tidal action that affect the distribution of pollutants in an estuary.

COND: From recall.

PL: Include:

a. Tide stage
b. Season
c. Wind conditions
d. Inflow into estuary
e. Relative water temperature
f. Densities
g. Flow

OBJ 3: List the effects of channel characteristics on reaeration.

COND: From recall.

PL: Include:

a. Velocity
b. Depth
c. Bottom roughness
d. Degree of saturation
e. Turbulence
f. Temperature
g. Pollutants
h. Aquatic growth

OBJ 4: Calculate reaeration coefficients and DO levels in bodies of water.

COND: Given equations such as Churchills, Streeter-Phelps, and Computer Programs for DOSAG, etc.

PL: 8 out of 10 problems correct.

OBJ 5: List the conditions for the accumulation and destruction of sludge deposits and the effect of these deposits.

COND: From recall.

PL: Include these conditions:
- a. Slope
- b. Roughness
- c. Velocity
- d. Depth
- e. Suspended load

Include these effects:
- a. DO usage
- b. Addition of BOD
- c. Change in suspended solids

OBJ 6: List the conditions which lead to biological accumulation and the effect of these deposits on the ability of a body of water to purity itself.

COND: From recall.

PL: Include these conditions:
- a. Depth
- b. Velocity
- c. Nature of bottom
- d. Nature of pollutants

Include these effects:
- a. Decrease in DO
- b. Increase in DO
- c. Changes in suspended matter

EQUIPMENT AND SUPPLIES

None

Sample Site Selection

ENV SCI 204:1, PL 3(99)

PURPOSE

This guide will assist you in evaluating the important factors to consider in selecting a sampling site. Samples representative of the water being monitored are an important aspect of surveys. The type of sample, and the location and time of sampling determine if a sample will yield useful data.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 2(99).

RESOURCES

IRIS: 879, 1331

OBJECTIVES

OBJ 1: List the factors involved in the selection of a sampling station.

COND: From recall.

PL: Include at least 10 of the following:

a. Objectives of stream study
b. Water uses
c. Access to sampling point
d. Mixing characteristics
e. Velocity
f. Time of travel
g. Variations of channel
h. Type of stream bed
i. Depth
j. Turbulence
k. Structures
l. Personnel available for study
m. Facilities available for study

OBJ 2: Discuss the importance of each of the following in deciding on a sampling point at a station:

a. Vertical mixing
b. Lateral mixing
c. Flow distribution
d. Depth
e. Distance from discharge
f. Upstream channel configuration

COND: Given the reason for the survey and a particular sampling station.

PL: Include at least one reason why each is important.

OBJ 3: Describe the selection of a sampling point(s).

COND: Given the following reasons for a survey:

a. Very accurate determinations
b. Average conditions of a cross section
c. Large river (0.5 mi wide)
d. Small stream (2 ft deep and 10 ft wide)
e. Stream with frequent bends
f. Stream with frequent pools
g. Lake for maximum plankton concentration
h. Stream for benthal discharge
i. Various distance below discharge

PL: 80% correct.

OBJ 4: Calculate average constituent concentration of pollutants after mixing.

COND: From recall.

PL: 90% correct.

OBJ 5: Explain the importance of selecting a sampling location.

COND: Given a list of factors, including:

a. Accessibility
b. Manpower
c. Maps
d. Types of sampling equipment
e. Types of vehicles
f. Type of sample
g. Purpose of survey
h. Control stations
i. Tributary stations
j. Channel or estuary characteristics
k. Type of bottom
l. Funds available
m. Personnel available

PL: Each factor must be considered and its importance weighed in making a selection. No more than two can be evaluated "unsatisfactory."

EQUIPMENT AND SUPPLIES

None

Sampling Procedures

ENV SCI 204:1, PL 4(100)

PURPOSE

This guide will assist you in preparing for and carrying out a sampling program. The sample brought to the lab for analysis must serve the purposes of the survey and be representative of the sampled location. A knowledgeable sample collector who is observant in the field contributes to the quality of a survey.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 3(99).

RESOURCES

IRIS: 4, 879, 1332

OBJECTIVES

OBJ 1: Prepare map of sampling locations.

COND: Given access to maps, resources.

PL: Include:
- a. Sources of maps
- b. Marking of location
- c. Designation of stations
- d. Designation of multiple points at a location

OBJ 2: Describe techniques for marking sampling location in field.

COND: From recall.

PL: Include the following:
- a. Marking (bridges, dams, trees, etc.)
- b. Floats
- c. Lining up objects

OBJ 3: List preliminary preparation required for sampling.

COND: Given IRIS 879, 1332 or notes.

PL: Include consideration of:
- a. Visit to site
- b. Selection of precise sampling point, depth, time, and features to note (e.g., river stage)
- c. Improving accessibility (path clearing, bridging)
- d. Vehicle condition
- e. Boat condition
- f. Metering equipment condition and calibration
- g. Reagent supply
- h. Sample bottle supply
- i. Sampling tags
- j. Sampling itinerary
- k. Ropes
- l. First aid equipment

OBJ 4: Demonstrate use of sampling devices.

COND: Given sampling device and location, including:
- a. APHA sampler
- b. Kemmerer sampler
- c. Ekman dredge
- d. Peterson dredge
- e. Artificial substrate device
- f. Bottom corer
- g. Sieve sampler
- h. Bucket sampler
- i. Plankton net
- j. Surber sampler

PL: Five successive samples taken correctly with each device.

OBJ 5: Clean sample containers.

COND: Given equipped laboratory, including the following types of sample containers for chemical, physical or biological analysis:

a. Plastic
b. Glass
c. Borosilicate glass

PL: A dozen containers cleaned at one time must be satisfactory.

OBJ 6: Describe and demonstrate general precautions to take in collecting sample.

COND: Given sampling containers for physical, chemical, biological samples, and these locations:

a. Tap
b. Flowing stream
c. Ponded stream
d. Lake (no flow)
e. Estuary (at various times)
f. Sewer
g. Treatment plant process units
h. Well

PL: Include the following:

a. Removing and holding cap
b. Handling bottle
c. Rinsing sample container
d. Location (depth, cross section)
e. Position of sampling person in body of water
f. Floating material
g. Samples at prescribed depth
h. Flushing lines

OBJ 7: List two tests for which only grab is suitable, only composite suitable or both are suitable.

COND: Given name of test and IRIS 4 or class notes.

PL: 100% correct.

OBJ 8: Fill out sample tag.

COND: Given tag, sample location, and sample requirements.

PL: All required information must be present.

OBJ 9: Describe preservation methods.

COND: From recall.

PL: Include:

a. pH control
b. Chemical additions
c. Refrigeration
d. Freezing

OBJ 10: List permissible time intervals between collection and analysis.

COND: Given IRIS 4, class notes, and name of analysis.

PL: 100% correct.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES									
	1	2	3	4	5	6	7	8	9	10
APHA sampler				x		x				
Kemmerer sampler				x		x				
Ekman dredge				x		x				
Peterson dredge				x		x				
Artificial substrate device				x		x				
Bottom corer				x		x				
Sieve sampler				x		x				
Bucket sampler				x		x				
Plankton net				x		x				
Surber sampler				x		x				
Plastic bottle					x	x				
Glass bottle					x	x				
Borosilicate glass bottle					x	x				
Soap					x					
Bottle brushes					x					
Cleaning solution					x					
Tap and distilled water					x					
Sample tag						x		x		

Sampling Routine

ENV SCI 204:1, PL 5(100)

PURPOSE

This guide will assist you in planning the logistics of a sampling program. For many surveys, it is necessary to obtain a representative, average measure of stream conditions. For other surveys, information may be desired on maximum or minimum conditions. A proper sampling program will provide such information.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 4(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: List the points that must be considered when determining the number of samples to be taken.

COND: Given resources.

PL: Include:
- a. Degree of precision of laboratory method
- b. Budget
- c. Personnel
- d. Facilities
- e. Time available
- f. Variability in water quality
- g. Degree of precision needed

OBJ 2: List the points that must be considered when determining the duration of a sampling survey.

COND: Given resources.

PL: Include:
- a. Objective of study
- b. Season
- c. Flow
- d. Budget
- e. Personnel
- f. Facilities
- g. Time available
- h. Variability in water quality

OBJ 3: List the points that must be considered when determining the frequency of sampling during a survey.

COND: Given resources.

PL: Include:
- a. Water use
- b. Urgency of developing a representative record of quality
- c. Capability for sample collection and analysis
- d. Objectives of study

OBJ 4: List the points that must be considered when determining the desirability of installing continuous monitoring equipment.

COND: Given resources.

PL: Include:
- a. Budget available
- b. Personnel
- c. Facilities
- d. Power availability

OBJ 5: Determine the number of samples, duration of sampling, frequency and suitability of continuous monitoring equipment.

COND: Given resources.

PL: For each of the following:

a. Establishment of a base-line record of water quality.
b. Investigation of suitability as a source of municipal, industrial or other water supply.
c. Investigation of suitability for recreational use.
d. Investigation of suitability for propagation of aquatic life.
e. Day to day monitoring of raw water sources of municipal, industrial, and other water supply.
f. Monitoring effects of waste discharges.
g. Surveillance to detect adherence to or violation of water quality standards.
h. Detection of sudden changes in water quality caused by slugs of wastes resulting from spills, deliberate discharges or treatment plant failures.
i. Determination of patterns of pollution down-stream from waste discharges and effects on water uses.
j. Determination of adherence to or violation of water quality standards.
k. Determination of characteristics and rates of natural purification of streams.
l. Projection of effects of pollution on conditions of flow and temperature other than those occurring during study.
m. Estimation of waste assimilation capacities of streams.
n. Estimation of reductions in waste loads necessary to meet water quality requirements.
o. Determination of causes of fish kills or other disasters involving deterioration of water quality.
p. Determination of existing water quality before some change in conditions, such as a new or increased waste discharge or impoundment of a reservoir.

EQUIPMENT AND SUPPLIES

None

Stream Flows

ENV SCI 204:1,PL 6(100)

PURPOSE

This guide will assist you in evaluating the effect of stream flow on water quality. Stream flow is an important factor in stream surveys, as it influences the quality of natural waters, as well as the effect a waste will have on a body of water.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 5(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: Describe the effect on water quality.

COND: Given the following conditions:
- a. Low flow on water quality
- b. High flow on water quality
- c. Low flow on mixing
- d. High flow on mixing
- e. Flow on time of travel

PL: Include:
- a. Physical, chemical, and biological parameters
- b. Flow on vertical, lateral, and longitudinal mixing

OBJ 2: Describe the effect on flow.

COND: Given the following circumstances:
- a. Precipitation patterns
- b. Temperature patterns
- c. Annual cycles of weather

PL: Include:
- a. Flood flows
- b. Drought flows (7-day minimum)

OBJ 3: Describe the effect on flow.

COND: Given flow data on the following types of impoundments:
- a. Power production
- b. Flood control
- c. Navigation
- d. Irrigation
- e. Recreation
- f. Water supply

PL: Include:
- a. Preparation of sample plots of discharge vs. time for each
- b. Effect of impoundment on peak and low flows

OBJ 4: Select time and duration of sampling period.

COND: Given resource material on:
- a. Objectives of survey
- b. Time of year study must be made
- c. Precipitation and temperatures expected
- d. Past flow records
- e. Personnel
- f. Facilities

PL: Solution must meet contraints in the conditions.

OBJ 5: List the sources of flow data and select a record.

COND: Given IRIS 879 and flow record resources.

PL: Include the following resources for flow records:

a. U.S. Geological Survey
b. U.S. Army Corps of Engineers
c. U.S. Bureau of Reclamation
d. NOAA (Weather Bureau)
e. U.S. Environmental Protection Agency
f. State agencies

EQUIPMENT AND SUPPLIES

None

Time-of-Water Travel

ENV SCI 204:1,PL 7(100)

PURPOSE

This guide will assist you in selecting procedures for measuring time-of-water travel and performing the measurement. In order to determine the change or rate of change of a soluble degradable constituent in the flow, it is necessary to know the time it takes for the constituent to flow from one point to another. Time-of-water travel studies provide this data.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 6(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: List the reasons for conducting a time-of-flow study.

COND: Given IRIS 879.

PL: Include:

a. Determine rate of change of degradable constituent.
b. Identify cause of fish kill.
c. Predict arrival time of spill.
d. Select sampling stations.
e. Decide on changes in river channel (elimination of curves, oxbows).

OBJ 2: Describe the methods for determining time of flow, and the type of study where applicable.

COND: Given IRIS 879.

PL: Include:

a. Surface floats
b. Measurement of cross section
c. Tracers
   1. salt
   2. radioisotopes
   3. rhodamine

OBJ 3: Perform a time-of-flow measurement.

COND: Given an equipped laboratory and field equipment.

PL: Two successive measurements at same flow should be within ± 5% of each other.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Surface floats			x					
Tape			x					
Salt			x					
Rhodamine			x					
Lab equipment for Cl determination			x					
Sample bottles			x					

Field Laboratory

ENV SCI 204:1,PL 8(100)

PURPOSE

This guide will assist you in organizing, setting up, and using a field laboratory for a water quality study. In many studies it is necessary to analyze some constituents in the field, as they are unstable and changes will take place in the sample before it can be analyzed in the main laboratory.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 7(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: Compare the advantages and disadvantages of field laboratories.

COND: Given IRIS 879.

PL: Include:
- a. These types of labs:
  1. trailer
  2. van
  3. boat
  4. station wagon
  5. treatment plant
  6. institution
  7. industry
- b. These restraints:
  1. cost
  2. space (sharing)
  3. mobility
  4. crew (driver, pilot)
  5. setting up
  6. access

OBJ 2: List the factors in scheduling work loads for a field lab.

COND: Given IRIS 879.

PL: Include:
- a. Numbers of samples
- b. Time for analyses
- c. Housekeeping duties
- d. Calculations
- e. Tabulations

OBJ 3: List the factors in preparing a field lab for operation.

COND: Given IRIS 879.

PL: Include:
- a. Operating condition of equipment
- b. Supplies
- c. Reagents
- d. Power source
- e. Water source
- f. Location for placement
- g. Waste disposal
- h. Time for set up prior to starting
- i. Orientation of personnel

OBJ 4: Plan for, set up and conduct a survey from a field laboratory.

COND: Given field laboratory, supplies, equipment, objectives for survey, and resources.

PL: Include:

a. Selection of lab
b. Equipping lab
c. Setting up lab
d. Planning work loads
e. Conducting survey
f. Changing survey schedules
g. Tabulating data
h. Shipping samples to main lab
i. Terminating and packing up

EQUIPMENT AND SUPPLIES

None

Sources of Information

ENV SCI 204:1,PL 9(100)

PURPOSE

This guide will assist you in finding resources which may help in planning a water quality study. In many cases previous studies on the watercourse under investigation or reports on similar studies are available to assist in planning and conducting surveys. These should be consulted in order to maximize the use of existing information and minimize cost and duplication.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 204: 1,PL 8(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: List sources of information on water quality studies.

COND: Access to sources and IRIS 879.

PL: Include:

a. State pollution control agency
b. State department of health
c. State fish and game agency
d. State planning agencies
e. State geological survey
f. Interstate pollution control agencies
g. U.S. Department of Interior
h. U.S. Environmental Protection Agency
i. U.S. Geological Survey
j. U.S. Coastal and Geodetic Survey
k. U.S. Bureau of Reclamation
l. U.S. Army Corps of Engineers
m. River development agencies
n. U.S. Fish and Wildlife
o. U.S. Bureau of Commercial Fisheries
p. U.S. Coast Guard
q. Local water and wastewater treatment plants
r. State highway departments
s. Conservation organizations
t. Sportsman organizations
u. Newspaper files
v. Individuals

EQUIPMENT AND SUPPLIES

None

Interpretation of Data

ENV SCI 204:1,PL 10(100)

PURPOSE

This guide will assist you in the development of data forms and the procedures for analyzing data obtained in water quality studies. The key to any survey is the interpretation given to all the data collected, as this is the basis for subsequent decisions. Care must be taken to acquire the right data in sufficient quantity so that statistical analyses can be made.

PREREQUISITES

Before beginning this module you should have successfully completed Math 102: 1-31(63-67); and Env Sci 204:1,PL 5-9 (100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: Develop data forms.

COND: Given objectives of survey.

PL: Forms must be suitable (compared with model form) for 16 types of surveys listed in Env Sci 204:1(99).

OBJ 2: Perform analysis of data

COND: Given data from each of the 16 types of surveys described in Env Sci 204:1(99).

PL: Include each of the following techniques:

- a. Study design
  - 1. randomization
  - 2. sample size
  - 3. subsampling
- b. Graphic examination
  - 1. raw data
  - 2. frequency histograms
  - 3. frequency polygon
  - 4. cumulative frequency
  - 5. two-dimensional graphs
- c. Sample means and variance
  - 1. stratified random samples
  - 2. subsamples
  - 3. rounding
- d. Tests of hypotheses
  - 1. t-test
  - 2. Chi-square test
  - 3. F-test
  - 4. analysis of variance
- e. Confidence intervals for means and variances
- f. Linear regression and correlation
  - 1. tests for hypotheses
  - 2. regression for bivariate data
  - 3. linear correlation

EQUIPMENT AND SUPPLIES

None

Report Preparation

ENV SCI 204:1,PL 11(100)

PURPOSE

This guide will assist you in the preparation of a final report of a water quality study. The final report from a field survey is usually the only result of the survey seen by the persons making decisions based on the study. The quality of the report can determine its usefulness to the persons reading it.

PREREQUISITES

Before beginning this module you should have successfully completed Eng 102(91) and Env Sci 204:1,PL 10(100).

RESOURCES

IRIS: 879

OBJECTIVES

OBJ 1: Prepare a report on a survey.

COND:
a. Involvement with the survey
b. Access to all data
c. Access to other persons involved in survey

PL: Include:
a. Tables
b. Graphics
c. Maps
d. Photographs
e. Text
1. table of contents
2. acknowledgements
3. introduction
4. summary
5. conclusions
6. recommendations
7. description of survey area
8. water uses
9. waste sources
10. study method
11. water quality data and discussion
12. calculations
13. appendices

EQUIPMENT AND SUPPLIES

None

Selection of Instrument for Stream Flow Measurement

ENV SCI 205:1(101)

PURPOSE

This guide will assist you in selecting a stream flow measuring instrument for a particular measurement. Many instruments and techniques are available for stream flow measurements. For each type of measurement there are particular instruments and techniques which will best obtain the measurements desired.

PREREQUISITES

Before beginning this module you should have successfully completed Math 102: 1-31(63-67).

RESOURCES

IRIS: 618, 2758, 2759

OBJECTIVES

OBJ 1: Identify stream flow measuring instruments.

COND: Given pictures or actual instrumentation, including:

a. Tape
b. Staff gauge
c. Pygmy current meter
d. Price current meter
e. Float recorder
f. V-notch weir
g. Rectangular weir
h. Parshall flume
i. Kenningson nozzle

PL: 100% correct.

OBJ 2: Determine the factors involved in selecting the appropriate instrument or device necessary for stream flow measurement.

COND: Given:

a. Manuals for the instruments or devices
b. Physical characteristics of the stream.
c. Characteristics of the instruments or devices
d. Costs of the instruments or devices
e. Installation costs of the instrument or device

PL: The choice of instrument or device must incorporate all of the listed conditions.

OBJ 3: Select a stream flow measurement instrument.

COND: Given:

a. These measurements:
    1. volume
    2. quantity of flow
    3. cross-sectional area
    4. velocity
b. Accuracy of measurement.

PL: 90% of instruments must meet accuracy requirement and be appropriate for measurement being made.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Tape	x							
Staff gauge	x							
Pygmy current meter	x							
Price current meter	x							
Float recorder	x							
V-notch weir	x							
Rectangular weir	x							
Parshall flume	x							
Kenningson nozzle	x							

Care of Stream Flow Measurement Instruments

ENV SCI 205:2(101)

PURPOSE

This guide will assist you in the procedures for maintaining and checking stream flow measurement instruments. Many stream flow measurement instruments are delicate and must be stored, transported, handled, and installed properly if useful results are to be obtained.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 205: 1(101).

RESOURCES

IRIS: 618, 2758, 2759

OBJECTIVES

OBJ 1: Describe and demonstrate the storage procedure for current meters.

COND: Given Pygmy and Price current meters and cases.

PL: Include:
- a. Type of case
- b. Placement in case
- c. Storage of moving parts
- d. Reason for handling with care

OBJ 2: Describe and demonstrate or check installation conditions of water stage devices.

COND: Given:
- a. Measuring instrument
- b. Location and description of location
- c. Type of measurement to be made

PL: Include:
- a. Agreement of staff gauge and recorder reading
- b. Chart condition
- c. Ink, pen or pencil condition
- d. Clock condition
- e. Condition of intake pipe

OBJ 3: Describe and demonstrate or check installation conditions of current meters.

COND: Given:
- a. Measuring instrument
- b. Location and description of location
- c. Type of measurement to be made

PL: Include:
- a. Condition of bearings before and after
- b. Problems with floating drift
- c. Condition of stop watch
- d. Electrical connections
- e. Very low flows
- f. Reason for verification of condition of equipment

OBJ 4: Describe and demonstrate or check installation conditions of weirs, flumes, nozzles, and meters.

COND: Given:
- a. Measuring instrument
- b. Location and description of location
- c. Type of measurement to be made

PL: Include:
- a. Material of device
- b. Condition of edges of surfaces
- c. Nappe condition
- d. Submergence
- e. Side contractions
- f. Distance relationships
- g. Location of head measurement
- h. Cross-sectional area of approach
- i. Head
- j. Obstructions upstream
- k. Level
- l. Suitability of device for measurement
- m. Reason for each of these to be verified

OBJ 5: Identify need for repair for an instrument.

COND: Given:
- a. Instrument
- b. Manufacturer's manual
- c. Resources

PL: 80% of instruments needing repair must be identified; only 20% of instruments not needing repair may be selected.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Pygmy current meter	x		x		x			
Price current meter	x		x		x			
Tape		x			x			
Staff gauge		x						
Float recorder		x		x				
Chart		x		x				
Ink		x		x				
V-notch weir				x	x			
Rectangular weir				x	x			
Venturi meter				x	x			
Parshall flume				x	x			
Kenningson nozzle				x	x			
Orifice meter				x	x			

Making Measurements with Stream Flow Measuring Instruments

ENV SCI 205:3(101)

PURPOSE

This guide will assist you in learning the techniques for measuring volume, velocity, and quantity of flow in a body of water. Water quality studies need flow measurements in order to determine flow quantities.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 205: 2(101).

RESOURCES

IRIS: 618, 2758, 2759

OBJECTIVES

OBJ 1: Measure the volume or cross-sectional area.

COND: Given:
- a. Tape
- b. Containers, including:
  1. cubical
  2. spherical
  3. conical
  4. pyramidal
  5. irregular
- c. Cross sections, including:
  1. square
  2. rectangular
  3. circular
  4. semi-circular
  5. triangular
  6. trapezoidal
  7. irregular

PL: Measurement to be within ± 1% of actual area.

OBJ 2: Measure the velocity of a stream of water.

COND: Given:
- a. Pygmy and Price current meter
- b. Cross section of channel or stream
- c. Velocities ranging from 0 to 10 fps
- d. With and without debris (ice, leaves, sticks, limbs, bed load movement)

PL: Include:
- a. Measurement to be within stated accuracy of instrument or device utilized
- b. Measurement at any point in cross section
- c. Average velocity of a vertical line in cross section including:
  1. two-point method
  2. six-tenths depth method
  3. vertical velocity curve method
  4. integration method

OBJ 3: Measure the quantity of flow of a stream of water.

COND: Given:
- a. Some combination of:
  1. float recorder
  2. staff gauge
  3. V-notch weir
  4. rectangular weir
  5. Parshall flume
  6. Kenningson nozzle

7. pressure gauge

b. Velocities ranging from 0 to 10 fps.

c. With and without debris (ice, leaves, sticks, limbs, bed load movement).

PL: Measurement to be within 5% of that made by a competent person.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Pygmy current meter		x						
Price current meter		x						
Float recorder			x					
Staff gauge			x					
V-notch weir			x					
Rectangular weir			x					
Parshall flume			x					
Kenningson nozzle			x					
Pressure gauge			x					
Tape	x							

Stream Flow Measurement Calculations

ENV SCI 205:4(101-102)

PURPOSE

This guide will assist you in learning the use of many mathematical aids in making calculations for water quality studies. Converting the data from flow measurements into useful information requires the use of nomographs, charts, tables, and formulas. This must be done accurately to be useful.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 205: 3(101).

RESOURCES

IRIS: 618, 2758, 2759

OBJECTIVES

OBJ 1: Calculate the results of volume, velocity or quantity of flow and interpret data.

COND: Given:

a. Results of measurement
b. Formulas
c. Coefficients
d. Discharge tables
e. Rating curves
f. Correction curves
g. Head-loss curves
h. Calibration curves
i. Conversion factors
j. Head-velocity tables
k. Three-halves power tables

PL: 95% of calculations and form of presentation must be that required by regulatory agency or plant management.

EQUIPMENT AND SUPPLIES

None

Appendix I
IRIS RESOURCES

CODE DEFINITIONS

AC	audio tape cassette	OT	overhead transparency
FS	35mm filmstrip	PM	printed matter
MP	motion picture	SL	35mm slide

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
4	Standard Methods for the Examination of Water and Wastewater	WPCF	PM
41	AWWA Standard for Sodium Chloride	AWWA	PM
60	AWWA Standard for Sodium Fluoride	AWWA	PM
108	Supervisors Workshop	NFI	PM
125	Operation of Wastewater Treatment Plants	WPCF	PM
142	Analysis of Wastewater Samples	NY Dept. of Health	PM SL
281	Supervisory Problems Workshop and Reference Manual	DuPont	PM
282	Temperature Measurement Basic Physics and Terms	DuPont	PM
283	Temperature Measurement Scales and Conversion	DuPont	PM
284	Temperature Measurement Thermometers	DuPont	PM
285	Titration and ITS Glassware	DuPont	PM
289	Water Treatment - Water Chemistry	DuPont	PM
291	Water Treatment - Water Testing	DuPont	PM
381	Office Management	Lansford	OT
399	Technical Report Writing (out of print)	Lansford	OT
404	Fundamentals of Analytical Chemistry	Lansford	OT
413	Determination of Alkalinity	EPA	AC PM SL
466	Alkalinity	EPA	AC PM SL

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
480	Our Environment Battles Water Pollution	Renn, C. E.	PM
481	Study of Water Quality	Renn, C. E.	PM
488	Investigating Water Problems - A Water Analysis Manual	Renn, C. E.	PM
538	Atomic Absorption	EPA WPO	AC PM SL
539	Chemical Oxygen Demand	EPA	AC PM SL
540	Dissolved Oxygen Determination	EPA	AC PM SL
542	Determination of Phosphorus	EPA	AC PM SL
547	Operational Control Tests for Activated Sludge Process - Part 3	EPA	AC PM SL
556	Residual Chlorine and Chlorine Demand	EPA	AC PM SL
557	Determination of Chemical Oxygen Demand	EPA	AC PM SL
618	Water Measurement Manual	Interior Dept.	PM
771	Determination of Total Organic Carbon	EPA	AC PM SL
830	Recommended Standards for Sewage Works - Ten State Standards	NY HES	PM
850	Use of Spectromic 20 Spectrophotometer	EPA	AC PM SL
879	Practical Guide to Water Quality Studies of Streams	Kittrell, F. W.	PM
902	Determination of Suspended Solids	EPA	AC PM SL
1017	Control of Sulphides in Sewerage Systems	Thistlelkwayte, D.	PM
1027	Applied Chemistry of Wastewater Treatment - Unit 8 - Applications - pH and Alkalinity	Mancy, K. H.	PM
1036	Water Quality Instrumentation, Vol. 2	Scales, J. W.	PM
1060	Sartorius Balance 2400	Slabaugh, W. H.	MP
1061	Colorimetry - Part I	Slabaugh, W. H.	MP
1062	Colorimetry - Part II	Slabaugh, W. H.	MP
1063	pH Meter	Slabaugh, W. H.	MP
1143	Titration	Kalmia	MP

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
1226	Writing Letters That Get Results	Roundtable	MP
1331	Biological Field Investigative Data for Water Pollution Surveys (out of print)	Ingram	PM
1332	Biological Associated Problems in Freshwater Environments - Their Identification, Investigation and Control	Mackenthun	PM
1352	How to Make Serial Dilutions	AIBS	AC FS PM SL
1363	How to Measure Water Hardness	AIBS	AC FS PM SL
1370	Laboratory Procedures - Analysis for Wastewater Treatment Plant Operators	Wietti, D.	PM
1413	How to Measure Dissolved Oxygen Content of Water	AIBS	AC FS PM SL
1414	How to Grow and Count Microorgansims on Membrane Filters	AIBS	AC FS PM SL
1426	Treatment and Disposal of Wastewater Sludges	Wesilind, P. A.	PM
1429	Atomic Spectrometric Analysis of Heavy Metal Pollutants in Water	Burrell, D. C.	PM
1505	Introduction to Environmental Technology - Vol. I of Wastewater Technology	Clemson University	PM
1506	Plant Operations for Wastewater Facilities - Vol. II of Wastewater Technology	Clemson University	PM
1583	Office Records Management	Lansford	OT
1755	Water Quality Parameters	ASTM	PM
1762	pH Meter - Laboratory Operation	EPA	AC PM SL
1795	Modern Chemical Technology - Vol. 5	ACS	PM
1823	Water Use Classifications and Standards of Water Quality	NEIWPCC	PM
1886	Temperature Measurement - Standards and Calibration	DuPont	PM
1915	Wastewater Treatment Technology	Patterson, J. W.	PM

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
2075	Processing Water Treatment Plant Sludge	AWWA	PM
2105	Common Laboratory Apparatus	Comm Skill	AC FS PM SL
2106	Pipetting Techniques	Comm Skill	AC FS PM SL
2110	pH Measurements	Comm Skill	AC FS PM SL
2116	Temperature	Mitchel, J. P.	AC FS PM SL
2122	pH, pOH and Buffers	Mitchell, J. P.	AC FS PM SL
2127	Dilution and Titration Problems	Mitchell, J. P.	AC FS PM SL
2134	Basic Relationships and Instrumentation Basic Gas Chromatography	McNair, H. M.	AC FS PM SL
2135	Column ITS Make Up and Use	McNair, H. M.	AC FS PM SL
2136	Detectors - Design and Use	McNair, H. M.	AC FS PM SL
2137	Sample Preparation Derivatives and Sampling Technique	McNair, H. M.	AC FS PM SL
2138	Column Temperature Programming	McNair, H. M.	AC FS PM SL
2139	Qualitative and Quantitative Analysis	McNair, H. M.	AC FS PM SL
2141	Derivatives for Gas Chromatography	McNair, H. M.	AC FS PM SL
2143	Principles of Atomic Absorption	Robinson, J. W.	AC FS PM SL
2144	Instrumental Requirements - Basic Atomic Absorption Spectroscopy Series	Robinson, J. W.	AC FS PM SL
2145	Optimizing Instrument Conditions - Basic Atomic Absorption Spectroscopy Series	Robinson, J. W.	AC FS PM SL
2146	Sample Preparation and Special Sampling Techniques	Robinson, J. W.	AC FS PM SL
2302	Basic Principles of the Analytical Balance	USPHS	MP
2510	Management and Supervision Procedures for Wastewater Facilities - Vol. IV of Wastewater Technology	Clemson University	PM
2534	Safety Pipetting	USNMAC	MP
2558	Self-Monitoring Procedures - Basic Parameters for Municipal Effluents - Staff Guide	EPA	PM

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
2559	Self-Monitoring Procedures - Basic Parameters for Municipal Effluents - Student Reference Manual	EPA	PM
2575	Hardness of Drinking Water and Public Health	Amavis, R.	PM
2758	Stream - Gauging Procedures	Corbett, D. M.	PM
2759	Field Manual for Research in Agricultural Hydrology	Holtan, H. M.	PM
2911	Basic Laboratory Techniques for NPDES	Bonnette, A. K., Lamb, D., Allen, J. F.	PM

Appendix II

NPDES TESTS

1. Alkalinity
2. BOD_5
3. COD
4. Total solids
5. Total dissolved solids
6. Total suspended solids
7. Total volatile solids
8. Ammonia
9. Kjeldahl nitrogen
10. Nitrate
11. Total phosphorus
12. Acidity
13. Total organic carbon
14. Hardness
15. Nitrite
16. Aluminum
17. Antimony
18. Arsenic
19. Barium
20. Beryllium
21. Boron
22. Cadmium
23. Calcium
24. Chromium VI
25. Chromium total
26. Cobalt
27. Copper
28. Iron
29. Lead
30. Magnesium
31. Manganese
32. Mercury
33. Molybdenum
34. Nickel
35. Potassium
36. Selenium
37. Silver
38. Sodium
39. Thallium
40. Tin
41. Titanium
42. Vanadium
43. Zinc
44. Organic Nitrogen
45. Orthophosphate
46. Sulfate
47. Sulfide
48. Sulfite
49. Bromide
50. Chloride
51. Cyanide
52. Fluoride
53. Chlorine
54. Oil and grease
55. Phenols
56. Surfactants
57. Algicides
58. Benzidine

59. Chlorinated organic compounds
60. Pesticides
61. Color
62. Specific conductance
63. Turbidity
64. Alpha, total
65. Beta, total
66. Radium
67. Fecal streptococci
68. Fecal coliform
69. Total coliform